U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

DOT HS 807 930
Final Report

June 1992

Measurement of Headlamp Aim and the Electrical and Photometric Performance Characteristics of Rear Lighting Systems

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 807 930		

4. Title and Subtitle	5. Report Date
Measurement of headlamp aim and the electrical and photometric performance characteristics of rear lighting systems	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s) Michael M. Copenhaver, and Robert E. Jones, Jr.	
9. Performing Organization Name and Address CAE-Link Corporation 5111 Leesburg Pike, Suite 300 Falls Church, VA 22041	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTNH-22-90-D-07010
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, DC 20590	13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code NHTSA

15. Supplementary Notes

Michael Perel, Contract Monitor, Office of Crash Avoidance Research

16. Abstract

The purpose of this study was to collect and analyze field data pertaining to a) headlamp aim, and b) rear lighting system electrical performance of a sample of vehicles representative of current makes/models.

Using mechanical aimers, headlamp aim data were collected from 768 vehicles; half from a periodic motor vehicle inspection (PMVI) state (Virginia) and half from a non-PMVI state (Maryland). Results showed that about 55% of Virginia vehicles had both headlamps aimed within the SAE standard compared with about 43% for Maryland vehicles. About 69% of newer vehicles (1991 models) had both headlamps aimed within the SAE standard as compared with about 35% for older vehicles (1986 models). There was no significant relationship found between headlamp aim and the number of months since inspection, fuel level, load, or headlamp type.

Rear lighting system voltage and amperage data were collected from 200 current model vehicles (1986-1991 models). Some newer vehicles (1991 models) had significantly higher voltage readings than some older model vehicles (1988 models) at the rear lighting system. Cars had signficantly lower voltage readings at the rear lighting system than vans, light trucks, and utility vehicles.

17. Key Words	18. Distribution Statement
Headlamp aim, vehicle lighting, safety	Document is available to the public from the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		189	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TECHNICAL SUMMARY

The purpose of this study was to collect and analyze "real world" data pertaining to a) headlamp aim, and b) rear lighting system electrical performance of current model vehicles 1986 - present). In addition, secondary data items of interest were obtained and analyzed during this study.

Using Hopkins Mechanical Aimers, headlamp aim data from 768 current model vehicles were collected from six different sites in the Northern Virginia/Maryland area. The sites were selected to provide a representative sample of cars, vans, light trucks, and utility vehicles manufactured from 1986 - 1991.

Overall, 49.2% of the vehicles from this sample were found to have both headlamps aimed within the SAE Lighting Inspection Code limits of plus or minus 4 inches (at 25 feet). There was a statistically significant difference between the aim of newer model vehicles and that of older models. The aim of 1991 model vehicles was relatively good; about 69% of these vehicles having both lamps aimed within the SAE limits. By contrast, only about 35% of 1986 model vehicles had both lamps aimed within SAE limits. Compared with an earlier NHTSA study (Winkler & Olson, 1985), the present study found about a 12% increase in aim compliance with SAE limits for current model vehicles and about a 7% increase in aim compliance for the older vehicles.

There was a statistically significant difference between the PMVI and non-PMVI states in terms of the percentage of vehicles found to have headlamps aimed within SAE limits. Vehicles from the PMVI state (Virginia) had better headlamp aim than vehicles from the non-PMVI state (Maryland). About 55% of Virginia vehicles had both headlamps aimed within SAE limits as compared with about 43% for Maryland vehicles. As compared with the 1985 NHTSA study (Olson & Winkler, 1985), the present study found about a 10% increase in compliance with SAE aim limits for the PMVI state and about a 6% increase in aim compliance for the non-PMVI state (although different geographical locations were used in the present study). No significant correlation was found between headlamp aim and the number of months since headlamp inspection, fuel level, vehicle load, or headlamp type.

Rear lighting system voltage/amperage data were collected from 200 current model vehicles (1986 - 1991) to compare "real world" voltages with those specified in NHTSA compliance test procedures for new lamps. Analyses revealed that about 74% of all the vehicles tested had voltage readings lower than 12.9 volts. A greater percentage of older model vehicles had voltage readings below 12.9 volts as compared with newer model vehicles.

Supplementary analyses were conducted to evaluate the factors affecting "real world" voltage readings. Cars had statistically significantly lower voltage readings at the rear

lighting system than vans, light trucks, and utility vehicles. On average, the voltage at the stoplamps was 12.07 volts for cars compared with about 12.95 volts for vans, light trucks, and utility vehicles.

Analyses of voltage data revealed that newer models (1991 vehicles) had significantly higher voltage readings than older models (1988 vehicles) at the stoplamps, presence lamps, and turn signal lamps. It was also discovered that some newer models (1990 vehicles) had significantly higher voltage readings at the battery than some older models (1988 vehicles).

A stoplamp having a voltage reading in the lower fifth percentile was identified from the data collected. A photometric test was conducted using NHTSA/SAE procedures for new lamps to determine how this low voltage reading would translate into photometric performance of the stoplamp. When tested at the field voltage (10.42 volts), this stoplamp had intensities that were lower than the limits specified in FMVSS 108, which apply to new lamps tested at the voltage prescribed by SAE recommended practices. Based solely on the field data, several other lamps in the sample may have produced similar results.

ACKNOWLEDGEMENTS

This project was made possible through the support and cooperation of several people independent of CAE-Link personnel. Special thanks goes to Mr. Jim Grab and staff at the Fredericksburg Auto Auction for allowing data collectors to obtain rear lighting system measurements from vehicles at the auto auction site. With respect to the headlamp aim portion of the study, in Maryland, sincere appreciation goes to Mr. Jim Brandenburg, Mr. Al Johnson, Mr. Bruce Diehl, and all personnel at Maryland Emissions Inspection Station #8 who provided tireless assistance to our data collection efforts. In Virginia, our gratitude is offered to Mr. Jerry Daggle, Mr. Ray Bates, and staff at Pinecrest Exxon; Mr. Chick Beaulieu, Mr. Robert Michanco, and staff at Sugarland Shell; Mr. Joe Kelley, Mr. Steve Kelley, and staff at Alexandria Exxon; and Mr. Ronald Harrell, Mr. Scott Simpson, and staff at Ravensworth Mobil for their generous support during the headlamp aim data collection endeavor. Sincere appreciation is offered to Ed Lipson and Carl Pittman of Hopkins Manufacturing Corporation, for their time and effort during headlamp aim data collection. Special thanks must also be given to Corkie Dykeman, Joan Sterling, and Mary Moore of ETL photometric laboratory as well as Kristen Helsel of General Motors Corporation, all of whom made the photometric testing portion of the study possible. Appreciation is given to all those mentioned above and to all others who participated in this research.

PREFACE

This report details the data collection procedure conducted and the analyses performed in support of Contract DTNH22-90-D-07010 (Task #16), Measurement of Headlamp Aim and Electrical and Photometric Performance Characteristics of Rear Lighting Systems of In-service Privately Owned Standard Automobiles -- Phase II.

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1.0 INTRODUCTION

1.1 Background

Safe operation of vehicles is greatly dependent upon the proper functioning of headlamps and rear lamps. With respect to the headlamp system, the aim of the lamps must be correct in order to provide the driver with necessary illumination while not hindering the vision of neighboring drivers. Since the last National Highway Traffic Safety Administration (NHTSA) sponsored survey of headlamp aim in 1985 (Olson, & Winkler, 1985), numerous modifications in headlamp design have resulted in the need to reassess the degree of misaim in the standard automobile fleet (including cars, vans, and light trucks), Data pertaining to headlamp aim are also currently required for the development of recommendations for a headlamp system performance standard. Thus, at present, the collection of headlamp aim data is of considerable importance.

The rear lighting system is also critical in the safe operation of the standard automobile. Rear lamps serve to establish the presence of a vehicle to nearby traffic as well as to provide early warning of the driver's intention to change lanes, turn, or stop. The effectiveness of rear lamps can be significantly reduced if the electrical power to the lamps is not at a level sufficient to produce the necessary illumination. For instance, a reduction in power to the rear lighting system could reduce rear lighting photometrics; thus impacting the ability of a following driver to differentiate between a leading car's braking, turn signaling, and continuing action (Sivak, Flannagan, & Olson, 1987). In addition, since a NHTSA sponsored study of the rear lighting system in 1982 (see Bonvallet & Hotchkin, 1982) various modifications to rear lighting systems have been implemented. Most importantly, there is interest in establishing how "real world" rear lighting system performance characteristics compare with those obtained under standard testing conditions.

1.2 General Approach

In an effort to determine the present state of headlamp aim and rear lighting system electrical and photometric performance characteristics of in-service standard automobiles, CAE-Link scientists in conjunction with NHTSA personnel, established: a) methods of obtaining the data required to support these evaluations, b) appropriate data collection sites, and c) sample sizes. Phase I, a pilot phase, was used to plan, design, and rehearse the general approach to resolve issues related to a-c above in preparation for official data collection activities in Phase II, the present phase. During Phase I, headlamp aim data were collected from 31 standard vehicles at three different data collection sites; rear lighting system measurements were obtained from 17 standard vehicles at one data collection site.

At the conclusion of Phase I, all aspects of data collection activities were examined, and modifications were implemented as needed to produce the general approach for Phase II. The general approach used for each part of the study will be addressed separately below.

With respect to the headlamp aim part of the study, data were collected using Hopkins Manufacturing Mechanical Headlamp Aimers which measure the level of the headlamps relative to the floor slope and to each other, respectively. Using mechanical aimers, headlamp aim data were collected from vehicles from the state of Virginia and the state of Maryland in order to represent a Periodic Motor Vehicle Inspection (PMVI) state and a non-PMVI state, respectively. Vehicles registered in Virginia (because it is a PMVI state), are required to undergo complete standard inspections including headlamp aim testing at annual intervals and emissions inspections at semi-annual intervals. Vehicles registered in Maryland (because it is a non-PMVI state), are only required to undergo a complete standard inspection including headlamp aim testing at times of ownership transfer (e.g., purchase of a vehicle), but are required to undergo an emissions inspection semi-annually. Data collection sites were selected in PMVI and non-PMVI states to allow a means to compare headlamp aim measurements of vehicles registered in states that differ in terms of headlamp aim inspection policy. Moreover, this approach allowed a means to compare present headlamp aim findings with those obtained in similar NHTSA sponsored studies (see Olson & Winkler, 1985; Hull, Heminion, Cadena, & Dial, 1972) which examined other PMVI and non-PMVI states in terms of headlamp aim.

The Maryland Emissions Inspection Station #8 in Capital Heights, MD was selected as the headlamp aim data collection site for registered Maryland vehicles. Likewise, the following locations were selected as headlamp aim data collection sites for registered Virginia vehicles: 1) Service station in Old Town Alexandria, Virginia, 2) Service station in Alexandria, Virginia, 3) Service station in Fairfax, Virginia, 4) Service Station in Annandale, Virginia, and 5) CAE-Link Corporation Parking Facility in Old Town Alexandria, Virginia.

A sample size required to support the headlamp aim portion of the study was established. A sample of 768 vehicles manufactured no earlier than 1986 was required; approximately half of these vehicles from Maryland and half from Virginia (see Appendix A for sample size justification).

With respect to the rear lighting system measurement part of the study, a Fluke multimeter (NIST certified) in conjunction with specialized voltage and amperage probes was used to obtain voltage and amperage readings. The probes selected allowed convenient collection of voltage and amperage data without causing damage to the wiring or

surroundings of the rear lighting system. These data were obtained at the following sites: 1) Fredericksburg Auto Auction (in Fredericksburg, Virginia) and 2) CAE-Link Corporation Parking Facility.

An appropriate sample size for the rear lighting portion of the study was established. Voltage and amperage data were collected from a total of 200 vehicles manufactured no earlier than 1986 to support this portion of the study.

2.0 REQUIRED RESOURCES

The Evaluation of the Alignment of Headlamps and the Photometric and Electrical Performance Characteristics of Rear Lighting Systems of In-service Privately Owned Automobiles -- Phase II, required the following resources for the two separate measurement operations:

Headlamp Alignment Measurement

- At least one primary data collection site per state in Maryland and Virginia. The designated sites were characterized by large, level floor areas and convenient daytime access to a large number and variety of vehicles manufactured from 1986-present,
- Headlamp measurement equipment: Hopkins Manufacturing Corporation 1016A Aimer Devices (mechanical headlamp aimers; see Figure 1 on p. 2-3),
- Common hand-held tape measure, and
- Standard data collection forms approved by NHTSA in Phase I of the study (see Appendix B).

Rear Lighting System Measurement

- A primary data collection site with convenient daytime access to a large quantity and variety of vehicles manufactured from 1986-present,
- A fully calibrated Fluke multimeter (NIST certified) used to obtain and display readings of electrical performance characteristics (see Figure 2 on p. 2-4),
- An amperage (current) and a voltage probe used to obtain measurements of electrical performance characteristics (see Figures 3 and 4 on p. 2-5),
- A common thermometer used to obtain measurements of the ambient air temperature,
- Hand tools including a standard screw driver, a phillips head screw drivers, a torque screwdriver, pliers, and wrenches required to gain access to the wiring of the lighting system at the rear of vehicles,

- A common hand-held tape measure used to measure the length of vehicles,
- A six foot flexible plastic hose used to redirect exhaust away from data collectors while at the rear of operating vehicles,
- Access to services of a photometric laboratory for photometric testing of the voltage data collected, and
- Standard data collection forms approved by NHTSA in Phase I of the study (see Appendix C).

Figure 1: Photograph of mechanical headlamp aimers

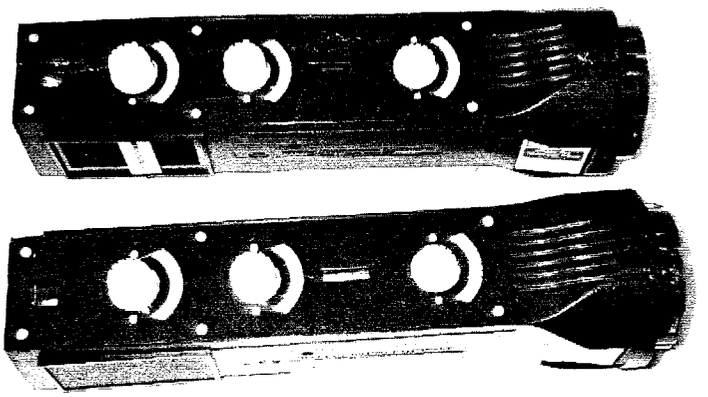


Figure 2: Photograph of multimeter used to obtain and display voltage and amperage readings

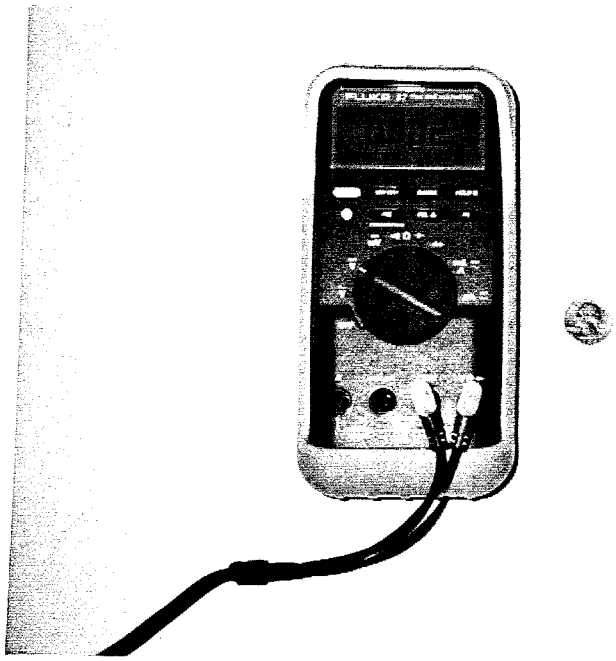
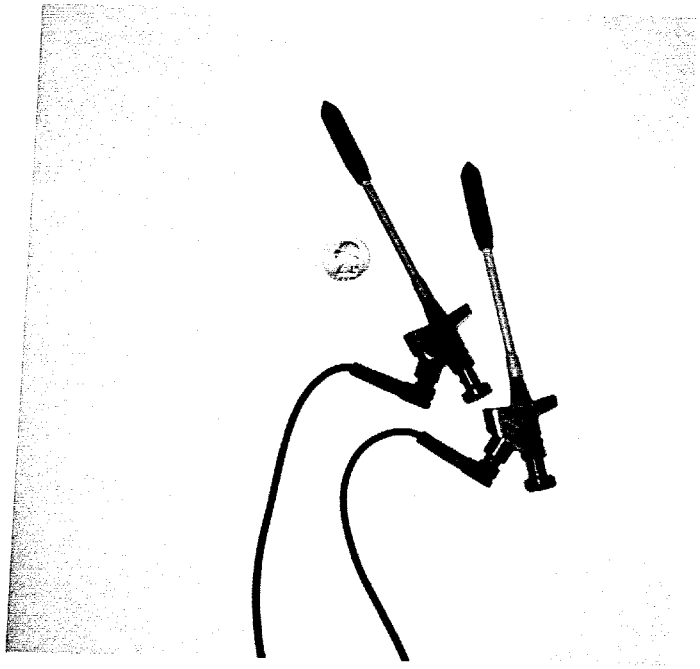


Figure 3: Photograph of amperage probe used to obtain amperage readings

Figure 4: Photograph of voltage probe used to obtain voltage readings



3.0 METHODOLOGY

3.1 Objective

Phase II of this study had two principal objectives. The first objective was to measure headlamp aim of standard in-service automobiles. The effectiveness of this procedure was evaluated in Phase I of this study at three data collection sites and was redesigned as required by NHTSA in preparation for the present data collection requirement. The specific procedure by which CAE-Link scientists met this objective is described in Section 3.2 below. The second objective was to measure the electrical performance characteristics of rear lamps of standard in-service automobiles. The methodology used for this data collection was examined in terms of effectiveness in Phase I and was modified as required by NHTSA. The specific procedure used to satisfy this objective is described in Section 3.3 below.

It should be noted that although the common objective for each of the two portions of this study was to implement a data collection procedure, and although data collection activities for each occurred during the same general time frame, the actual measurements proceeded in a completely independent fashion. That is, the measurement of headlamp aim did not occur in concert with the measurement of rear lamp voltage, amperage, and photometrics.

3.2 Data Collection Procedures for Headlamp Aim Measurement

3.2.1 Data collection sites

Headlamp aim data were obtained from vehicles displaying either Maryland or Virginia license plates. It was most efficient to collect these data in a separate fashion; data from Maryland vehicles collected at sites in Maryland and data from Virginia vehicles collected at sites in Virginia. The Maryland Emissions Inspection Station #8 was selected as the headlamp aim data collection site for Maryland vehicles. For Virginia vehicles, the following locations were selected as headlamp aim data collection sites: 1) Service station in Old Town Alexandria, Virginia, 2) Service station in Alexandria, Virginia, 3) Service station in Fairfax, Virginia, 4) Service Station in Annandale, Virginia, and 5) CAE-Link Corporation Parking Facility in Old Town Alexandria, Virginia. Several prospective data collection sites were examined in Maryland and Virginia; those listed above were selected based primarily on the volume and variety of vehicles available for headlamp aim measurement.

3.2.2 Data collection procedure

Before any headlamp aim measurements were taken, CAE-Link scientists determined what surface areas were to be used for testing headlamp aim (i.e., areas where vehicles would be positioned during testing). For instance, at the Maryland Emissions Inspection Station site, designated surface areas were where vehicles were situated during emissions testing, while at service station sites in Virginia, designated surface areas were the areas adjacent to the gasoline pumps. After surface areas were selected, the mechanical aimers were calibrated for the slope of the each selected area. Calibration readings of the measurement devices were then recorded for each surface area. Thus, before initiating the aim measurements, data collectors pre-set the mechanical aimers in accordance with the particular surface being used. The surface areas were marked so that a determination could be made as to whether a vehicle was situated within the proper area (see Figure 5 below).

Figure 5: Photograph of automobile positioned in designated surface area

Upon completion of the slope calibration process, the vehicle selection process began. Efforts were made to obtain aim data from a representative number of vehicles of each model year (1986-1991 models) from Virginia and Maryland (see Table 1 below).

Table 1: Percentage of each vehicle model year in the actual population and in the present sample classified by state

STATE	VEHICLE MODEL YEAR	*% OF ACTUAL POPULATION	% OF PRESENT SAMPLE
Virginia	1986	not available	14%
	1987	22%	15%
	1988	22%	16%
	1989	22%	16%
	1990	20%	16%
	1991	12%	21%
Maryland	1986	not available	18%
	1987	21%	24%
	1988	22%	25%
	1989	22%	10%
	1990	20%	12%
	1991	13%	10%

*Based on extrapolation from 1990 vehicle registration data

The average vehicle model year of the present sample was slightly higher for Virginia vehicles (mean model year = 88.7) as compared with Maryland vehicles (mean model year = 88.0). The primary reason for this is that new model vehicles are not required to have emissions tested. Therefore, relatively few newer model vehicles passed through the Maryland Emissions Inspection Station data collection site as compared with the service station data collection sites in Virginia (see Table 1 above). Approximately 75% cars and 25% vans, light trucks, and utility vehicles were selected to provide a representation of the types of vehicles registered in Maryland and Virginia manufactured from 1986-present).

One person (Person 1) approached the driver of the vehicle, politely asked for voluntary participation, briefly described the study, the sponsor of the study (U.S. DOT), and the length of time required to take the aim measurements (approximately five minutes).

Simultaneously, the other person (Person 2) determined the type of adapters required to fit the mechanical aimers onto the headlamp lens.

If the driver consented to participate in the study (only about 5% of prospective participants declined), Person 1 asked him/her to briefly activate the headlamps (to ensure that they were in working condition), and then obtained secondary data (i.e., current date, data collection location, state of license plate, date of last inspection, vehicle type, make/model/and year of vehicle, odometer reading, lamp/bulb replacement history, lamp aiming history, fuel status, load if any, vehicle identification number, lamp design, lamp make/model, lamp mounting height, observed condition of headlamps, and aim adapter readings) while Person 2 attached the aimers to the headlamp lenses.

After Person 1 completed collection of the secondary data items, and after the driver assumed the normal driving position (and after passengers, if any, assumed proper positioning), assistance was provided to Person 2 in finalizing the headlamp aim measurements. After the aim readings were recorded, the data collection form was examined by Person 1 to ensure that all items had been properly completed. If any item was not addressed, whenever possible it was then completed. Upon completion of the data collection form, this process was repeated with the next participant.

As a quality control effort, equipment (i.e., the Hoppy mechanical aimers) were properly calibrated and continuously inspected for possible causes of error as recommended in the Hoppy instruction manual. As an additional quality control measure, at the end of each data collection day, the forms were inspected by an independent CAE-Link scientist (who was not involved in the data collection process).

3.3 Data Collection Procedure for Rear Lighting System Measurement

3.3.1 **Data collection sites**

Rear lighting system data were obtained from standard vehicles at the following sites: 1) Fredericksburg Auto Auction (in Fredericksburg, Virginia) and 2) CAE-Link Corporation Parking Facility. The majority of the voltage and amperage data were collected from the Fredericksburg Auto Auction site since it offered a greater quantity and variety of standard automobiles.

3.3.2 **Data collection procedure**

An effort was made to obtain data from a variety of makes/models manufactured from 1986-present that had no obvious electrical deficiencies or other factors (e.g., inability to access wiring system, dead battery, etc.) that would preclude or interfere with accurate

measurement. Approximately 75% cars and 25% vans, light trucks, and utility vehicles were selected to represent the types of vehicles registered in Virginia that were manufactured from 1986-present.

The engine was started and vital signs (electrical system in particular) were checked. All secondary data items (i.e., vehicle type, make/model/and year of vehicle, odometer reading, make/model of stop and presence lamps, ambient air temperature, vehicle length, number of bulbs, configuration of lamps, whether turn signal lenses were amber, comments, date, and location) were collected before obtaining primary data items.

Both the right and left rear lamp assemblies were accessed by carefully removing whatever protective covering was present. Next, the stop, presence, and turn signal bulbs and respective wiring were differentiated. At this point, one person (Person 1) was positioned in the driver's seat while the other person (Person 2) was positioned at the rear of the vehicle working with the rear wiring.

Person 2 situated the multimeter, extensions, and probes in preparation for the measurements (see Section 2.0 for detailed information regarding measurement equipment). Person 1 placed a data collection form in position to record the readings as Person 2 obtained them and called them out. The first measurement obtained was amperage from the left stop lamp while the engine was at a low idle (approximately 750 RPM). Second, the measurement was repeated while Person 1 simultaneously increased the engine speed to a higher idle (approximately 2,000 RPM). At this time, the multimeter and measurement probes were adjusted so that voltage measurements could be obtained in the same manner (at a low idle then higher idle). When this was complete, the same procedure occurred for the left presence lamp, and left turn signal lamp. Upon completion of the measurements of the left rear lamps, the exact procedure was repeated for the stop, presence, and turn signal lamps at the right side of the rear lighting system. See Figure 6 below for a diagram of how amperage and voltage measurements were obtained.

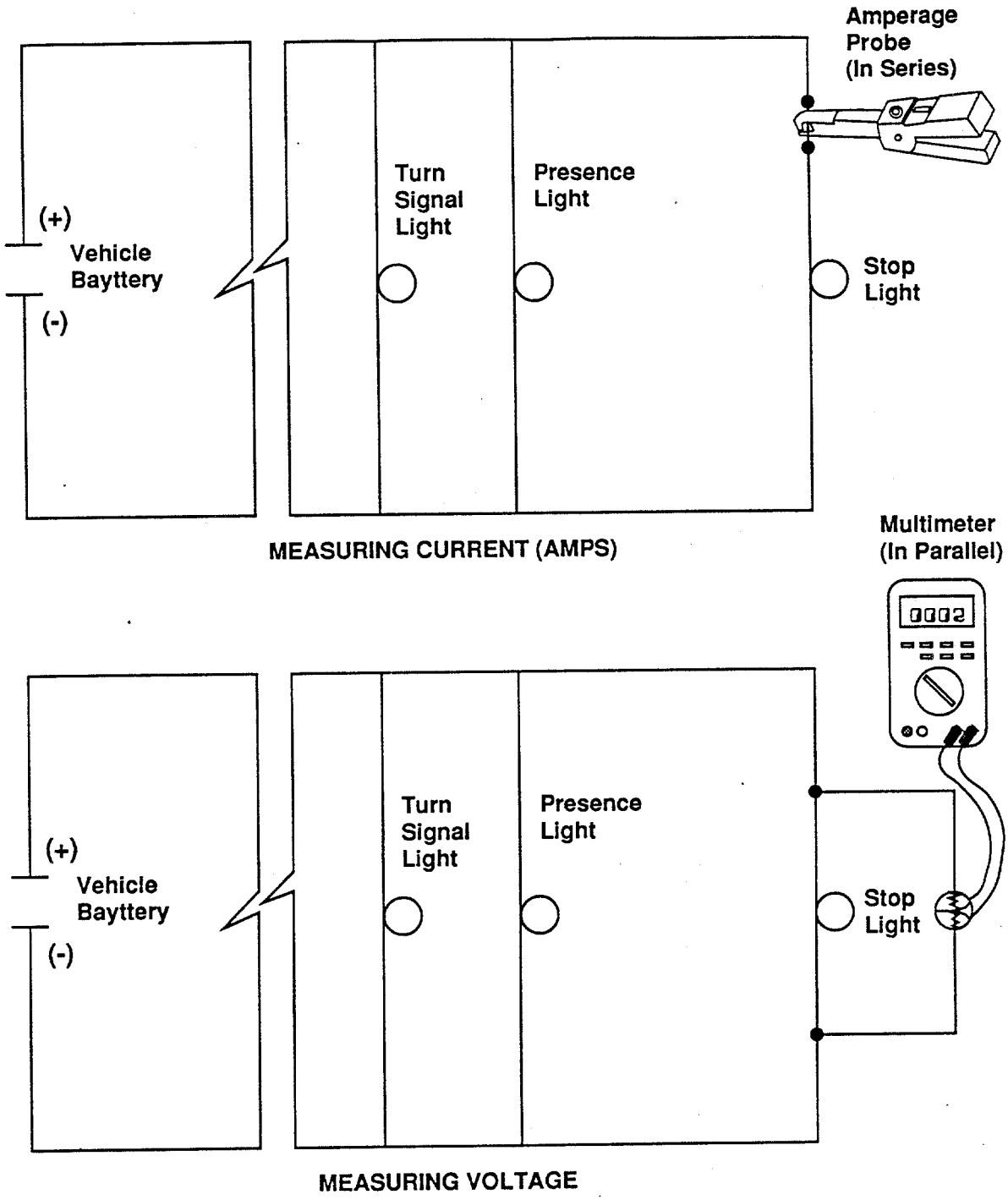


Figure 6: Wiring diagrams of where amperage and voltage measurements were taken

After all desired amperage and voltage measurements were obtained from the rear lighting system, a voltage measurement at low and high idle was taken by Person 2 at the battery terminals of the vehicle. As before, this information was called out by Person 2 and recorded on a data collection form by Person 1.

At the conclusion of the measurement and recording, the data collection form was examined by Person 1 to ensure that all items had been properly completed. If any item was not addressed, it was then completed. If the data collection form was complete, a search was then initiated for another prospective vehicle and the whole process was then repeated. If it was determined that the voltage or amperage readings were questionably high or low, additional verification measures were obtained from the same vehicle.

As a quality control effort, equipment (i.e., multimeter, amperage probe) were properly calibrated and inspected for possible causes of error. In order to avoid duplicating the data collection process on the same vehicle, the vehicle identification number was recorded for each vehicle. As an additional quality control measure, at the end of each day of data collection, the forms were examined by an independent CAE-Link scientist (who was not involved in the data collection process).

After completing the field data collection with respect to the amperage/voltage measurements, CAE-Link scientists supported NHTSA in identifying a stoplamp having a lower 5th percentile voltage reading. A similar make/model stoplamp was measured in a photometric lab to determine its intensity levels produced with the field measured voltage, with the voltage prescribed under NHTSA/SAE procedures for new lamps, and with an intermediate voltage level.

3.4 Sample Size and Data of Interest

For both the headlamp aim and the rear lighting system portions of the study, data were obtained from cars, vans, and light trucks (trucks that weigh less than 10,000 pounds). A sample was obtained that was composed of 75% cars and 25% vans, light trucks, and utility vehicles which was representative of registered vehicles manufactured from 1986-present. The selected sample size for each type of measurement is displayed below.

Table 2: Sample size for each measurement

Type of Measurement	Sample Size
Headlamp Aim	768
Rear Lighting System	202

With respect to the specific data that were obtained during Phase II data collection activities, Tables 3 and 4 provide this information for each measurement, respectively:

Table 3: Data obtained during headlamp aim measurements

1. Date at Time of Data Collection
2. Location of Site
3. State of License Plate (MD or VA)
4. Date of Last State Inspection
5. Vehicle Type
6. Vehicle Make/Model/Year
7. Odometer Reading
8. Lamp/Bulb Replacement History
9. Lamp Aiming History
10. Status of Fuel Gauge
11. Vehicle Load (if any)
12. Vehicle Identification Number
13. Headlamp Design
14. Headlamp Make/Model
15. Headlamp Mounting Height
16. Observed Condition of Headlamps
17. Aim Adapter Readings
18. Aim of Headlamps

Table 4: Data obtained during rear lighting system measurements

1. Vehicle Type
2. Vehicle Make/Model/Year
3. Odometer Reading
4. Make/Model of Rear Lamps
5. Lens Markings of Rear Lamps
6. Amperage/Voltage at Stop/Presence/ Turn Signal Lamps
7. Voltage at Battery
8. Ambient Air Temperature
9. Vehicle Length
10. Configuration of Rear Lamps
11. Whether Turn Signals Were Amber
12. Date at Time of Data Collection
13. Location of Site
14. Photometric Readings

Data elements contained in Table 3 and Table 4 were approved by NHTSA following Phase I as being within the scope of the test resources and of interest to the objectives of this study. Upon completion of all Phase I pilot activities, data collection forms were modified as required by NHTSA for both measurements. The forms ultimately evolved into the official data collection forms shown in Appendix B (for Headlamp Aim Measurement) and Appendix C (for Rear Lighting System Measurement).

4.0 ANALYSES

Data collected during both portions of the study were statistically analyzed using SPSS-PC+. Frequency distributions, histograms, and summary statistics were generated that provide a complete visual representation of data items related to headlamp aim (see Appendix D). In addition, correlational analyses were conducted to explore the possibility of significant relationships between variables examined in the study (see Appendix E).

Analyses were also conducted on data pertaining to two separate issues related to headlamp aim. First, analyses were performed on a small quantity of data that were collected before and after vehicles were filled with fuel. Summary statistics of headlamp aim data as affected by fuel level can be found in Appendix F. Second, analyses were conducted on a small quantity of data that were collected using a state-of-the-art Hopkins Fractional Balance Aimer (which measures photometric characteristics of headlamps such as beam patterns vs the relative level of the headlamp assembly as the mechanical aimers measure). Summary statistics of headlamp data collected using the Hopkins Fractional Balance Aimer can be found in Appendix G.

Statistical analyses of data obtained during the rear lighting portion of the study included complete frequency distributions, histograms, and summary statistics (see Appendix H). Moreover, correlational analyses were conducted to explore the relationships between variables addressed in this study (see Appendix I).

5.0 RESULTS AND DISCUSSION

5.1 Raw Data

Raw data collection forms from the headlamp aim portion of the study and the rear lighting portion of the study were provided to NHTSA. Raw data from both portions of the study were statistically analyzed using SPSS-PC+.

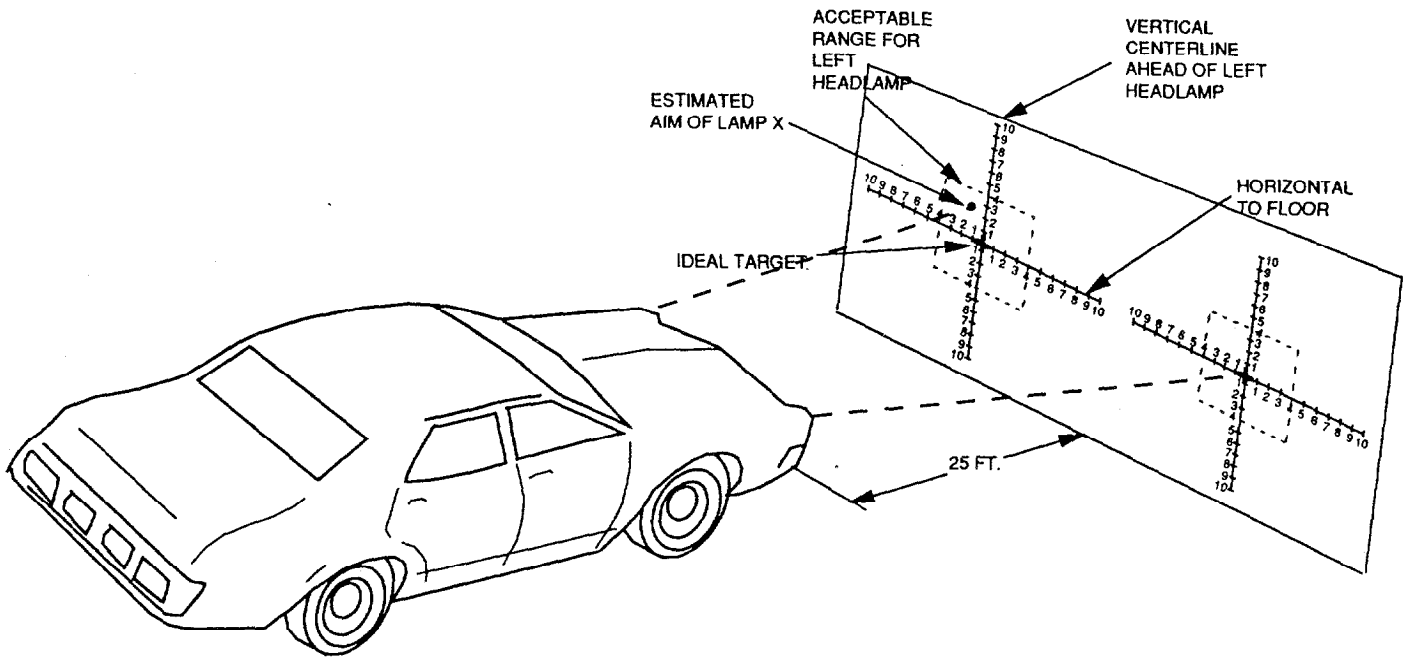
5.2 Analyses and Interpretation

5.2.1 **Headlamp aim data**

Aim measurements obtained using the mechanical aimers are in terms of inches of deviation from the ideal horizontal and vertical target at a distance of 25 feet (see Figure 7 on the following page). For example, as shown in Figure 7, if the aim of Lamp X is vertical aim = up 1.5 inches and horizontal aim = left 2.5 inches, then the aim of that lamp would be 1.5 inches above and 2.5 inches to the left of the ideal target at a distance of 25 feet. The range within which the mechanical aimers can be adjusted is plus or minus 10 inches at 25 feet. Aim measurements can also be expressed in "degrees"; 1 degree corresponding to 5.24 inches at 25 feet. Thus, a headlamp that is misaimed 1 degree is aimed 5.24 inches from the ideal target at 25 feet.

In accordance with the current SAE Lighting Inspection Code, a vehicle should be rejected from the headlamp aim portion of inspection (in PMVI states) if headlamp aim is more than 4 inches up, down, to the left, or to the right of the ideal target at 25 feet when using the mechanical aimers. Thus, as shown below, in order for a vehicle to comply with the headlamp aim portion of inspection, each headlamp must be aimed within the acceptable range.

Figure 7: Representation of Mechanical Aiming of Headlamps



NOTE: GRID SCALE UNITS IN INCHES, DRAWING NOT TO SCALE

As mentioned above, the range within which the mechanical aimers can determine headlamp aim is plus or minus 10 inches at 25 feet. As a result of this range restriction, when data collectors encountered aim readings beyond this range, an indication was made that the aim measurements were outside the plus or minus 10 inch range and that the precise aim values could not be determined (this occurred for about 10% of the vehicles sampled). Although specific values could not be determined for the aim data outside the plus or minus 10 inch range, these data were nevertheless analyzed as valid (out of range) observations except when specific aim values were required. When specific aim values were required for an analysis, the data were truncated at plus or minus 10 inches at 25 feet. This truncation dilemma has been encountered in previous research (e.g., see Olson & Winkler, 1985) and was addressed in a similar manner.

After application of the truncation method just described, frequency distributions, histograms, and summary statistics of headlamp aim data (within plus or minus 10 inches at 25 feet) were generated and are displayed in Appendix D. This provides an overall summary of the aim data that were obtainable using the mechanical aimers.

5.2.1.1 Analysis of primary variables

Statistical analyses were performed on the headlamp aim data (only data within range of the mechanical aimers) to provide a summary of the aim data for the vehicles in this sample. As shown in Table 5 below, the vertical aim tended to be slightly up and the horizontal aim tended toward the left. Standard deviations for each measure were relatively large (approximately 3.4 inches for the vertical measure and 2.9 inches for the horizontal measure).

Table 5: Summary of headlamp aim data

MEASUREMENT	MEAN (inches)	STD DEV. (inches)
Vertical Aim of Left Headlamp	up .143	3.43
Horizontal Aim of Left Headlamp	left .824	2.81
Vertical Aim of Right Headlamp	up .231	3.37
Horizontal Aim of Right Headlamp	left 1.362	3.02

Statistical analyses were performed to determine the overall percentage of headlamps aimed within the SAE Lighting Inspection limits of plus or minus 4 inches vertically and horizontally. As shown in Table 6 below, approximately 76% headlamps were found to be vertically aimed within the SAE limits; approximately 81% were found to be horizontally

aimed within the standard. While this shows significant headlamp misaim, these statistics actually indicate improvement since 1985 when a similar NHTSA sponsored study (see Olson & Winkler, 1985) found approximately 65% of headlamps to be vertically aimed within the SAE limits; approximately 76% were horizontally aimed within the standard.

Table 6: Overall percentage of headlamps aimed within SAE limits (+-4 inches at 25 feet)

LEFT LAMP VERTICAL AIM (inches)	LEFT LAMP HORIZONTAL AIM (inches)	RIGHT LAMP VERTICAL AIM (inches)	RIGHT LAMP HORIZONTAL AIM (inches)
76.8%	82.6%	75.3%	78.8%

Analyses of variance were conducted to provide a summary of headlamp aim by vehicle model year. As shown in Table 7 below, the vertical aim tended to be up and the horizontal aim tended toward the left. The standard deviations are also large, particularly for older vehicles, indicating substantial variability among aim readings for these vehicles.

Table 7: Summary of headlamp aim data classified by vehicle model year

YEAR	HEADLAMP	VERTICAL AIM (inches) Mean (std dev.)	HORIZONTAL AIM (inches) Mean (std dev.)
1986	Left	down 0.08 (3.60)	left 0.05 (3.13)
	Right	up 0.18 (3.87)	left 1.67 (3.93)
1987	Left	up 0.41 (3.74)	left 0.96 (2.85)
	Right	up 0.38 (3.70)	left 1.44 (3.43)
1988	Left	up 1.04 (3.14)	left 0.64 (2.78)
	Right	up 0.82 (3.25)	left 1.60 (3.29)
1989	Left	down 0.33 (3.63)	left 0.57 (2.67)
	Right	up 0.14 (3.06)	left 1.40 (2.54)
1990	Left	up 0.18 (3.44)	left 0.87 (2.78)
	Right	up 0.33 (3.36)	left 1.17 (2.43)
1991	Left	down 0.16 (2.93)	left 1.25 (2.32)
	Right	up 0.19 (2.77)	left 1.35 (2.14)

Table 8 below may provide a more concrete portrayal of headlamp aim as related to vehicle model year. Although there were no statistically significant differences between the *actual* headlamp aim readings of vehicles of different years, there were statistically significant differences between vehicles of different model years in terms of the percentage found to have lamps aimed within SAE Lighting Inspection Code limits. About 70% of current-model vehicles had both headlamps aimed within the SAE limits; however, only about 35% of vehicles four years older had both headlamps aimed within the SAE limits. In general, these data show about a 10% improvement since a 1985 NHTSA study that examined headlamp aim relative to vehicle model year (see Olson & Winkler, 1985), and about a 25% improvement since a 1972 NHTSA study (see Hull, et al., 1972).

Table 8: Percent of vehicles having left, right, and both headlamps aimed within SAE limits (+-4 inches at 25 feet)

MODEL YEAR	LEFT LAMP	RIGHT LAMP	BOTH LAMPS
1986	61.0%	47.1%	35.8%
1987	56.3%	53.0%	35.7%
1988	68.1%	62.0%	50.3%
1989	66.3%	67.3%	51.5%
1990	69.1%	69.1%	55.4%
1991	76.5%	83.2%	68.9%

Specifically, a significantly greater percentage of 1991 vehicles had the left lamp aimed within SAE limits than 1986 vehicles ($z = 2.58$, $p < .05$). Similarly, a significantly higher percentage of 1990 vehicles had the left lamp aimed within SAE limits than 1987 vehicles ($z = 2.10$, $p < .05$). There was also a significant difference between the left aim of 1988 vehicles and that of 1987 vehicles ($z = 2.88$, $p < .05$); the 1988 vehicles had a greater percentage with left lamps aimed within SAE limits than 1987 vehicles (see Table 8 above).

Interestingly, there were many more differences between vehicles of different model years with respect to right headlamp aim (see Table 8 above). A significantly higher percentage of 1991 vehicles had the right lamp aimed within SAE limits than 1986 vehicles ($z = 6.02$, $p < .05$), than 1987 vehicles ($z = 5.21$, $p < .05$), than 1988 vehicles ($z = 3.85$, $p < .05$), than 1989 vehicles ($z = 2.74$, $p < .05$), and than 1990 vehicles ($z = 2.52$, $p < .05$). Similarly, a significantly greater percentage of 1990 vehicles had the right lamp aimed within SAE limits than 1986 vehicles ($z = 3.38$, $p < .05$), and than 1987 vehicles

($z = 2.68$, $p < .05$). The 1989 vehicles had a significantly greater percentage of the right lamps aimed within SAE limits than 1986 vehicles ($z = 2.88$, $p < .05$), as well as than the 1987 vehicles ($z = 2.27$, $p < .05$). In addition, a significantly greater percentage of 1988 vehicles had the right lamp aimed within SAE limits than did 1986 vehicles ($z = 2.48$, $p < .05$).

As shown in Table 8 above, there was also a trend for a greater percentage of newer model vehicles to have both lamps aimed within SAE limits standards as compared with older models. Specifically, a significantly greater percentage of 1991 vehicles had both lamps aimed within SAE limits than 1986 vehicles ($z = 5.52$, $p < .05$), than 1987 vehicles ($z = 5.44$, $p < .05$), than 1988 vehicles ($z = 3.10$, $p < .05$), than 1989 vehicles ($z = 2.64$, $p < .05$), and than 1990 vehicles ($z = 2.11$, $p < .05$). In addition, a significantly greater percentage of 1990 vehicles had both lamps aimed within SAE limits than 1986 vehicles ($z = 3.01$, $p < .05$), and than 1987 vehicles ($z = 3.18$, $p < .05$). Similarly, a significantly higher percentage of 1989 vehicles were found to have both headlamps aimed within SAE limits than 1986 vehicles ($z = 2.38$, $p < .05$), and than 1987 vehicles ($z = 2.51$, $p < .05$). Also, a significantly greater percentage of 1988 vehicles had both headlamps aimed within SAE limits than 1986 vehicles ($z = 2.42$, $p < .05$), and than 1987 vehicles ($z = 2.61$, $p < .05$).

The trend shown above in Table 8 was further explored to ascertain how the specific vertical and horizontal aim measurements compared between vehicles of different model years. Table 9 displays a similar trend as shown in Table 8 above; headlamp aim gradually deteriorating with increasing vehicle age. This finding is consistent with the trend shown in previous research (see Hull, et al., 1972; Olson & Winkler, 1985) and suggests that maintaining headlamp aim may be more difficult as a vehicle ages.

Table 9: Percentage of headlamp aim within SAE limits (+-4 inches at 25 feet) classified by vehicle model year

MODEL YEAR	LEFT LAMP VERTICAL AIM	LEFT LAMP HORIZONTAL AIM	RIGHT LAMP VERTICAL AIM	RIGHT LAMP HORIZONTAL AIM
1986	74.0%	78.1%	67.5%	72.9%
1987	71.5%	77.5%	69.5%	70.1%
1988	75.8%	85.4%	72.6%	77.1%
1989	79.2%	81.2%	77.2%	83.2%
1990	75.5%	84.6%	77.3%	87.3%
1991	85.7%	89.1%	89.9%	90.8%

Beginning with the vertical aim of the left headlamp, a significantly greater percentage of 1991 vehicles were found to have the vertical aim of the left headlamp within SAE limits than 1986 vehicles ($z = 2.34$, $p < .05$), than 1987 vehicles ($z = 2.78$, $p < .05$), than 1988 vehicles ($z = 2.02$, $p < .05$), and than 1990 vehicles ($z = 1.962$, $p < .05$). In addition, a significantly greater percentage of 1991 vehicles were found to have the horizontal aim of the left headlamp within SAE limits than 1986 vehicles ($z = 2.29$, $p < .05$), and than 1987 vehicles ($z = 2.46$, $p < .05$). There were no other significant differences between vehicles of different model years with respect to the vertical or horizontal aim of the left headlamp.

There were also several significant differences between vehicles of different model years in terms of specific aim measurements of the right headlamp. A significantly greater percentage of 1991 vehicles were found to have the vertical aim of the right headlamp within SAE limits than 1986 vehicles ($z = 4.48$, $p < .05$), than 1987 vehicles ($z = 4.00$, $p < .05$), than 1988 vehicles ($z = 3.53$, $p < .05$), than 1989 vehicles ($z = 2.56$, $p < .05$), and than 1990 vehicles ($z = 2.62$, $p < .05$). Furthermore, a significantly greater percentage of 1991 vehicles were found to have the horizontal aim of the right headlamp within SAE limits than 1986 vehicles ($z = 3.65$, $p < .05$), than 1987 vehicles ($z = 4.14$, $p < .05$), and than 1988 vehicles ($z = 2.98$, $p < .05$). Likewise, a significantly greater

percentage of 1990 vehicles were found to have the horizontal aim of the right headlamp within SAE limits than 1986 vehicles ($z = 2.88$, $p < .05$), than 1987 vehicles ($z = 3.24$, $p < .05$), and than 1988 vehicles ($z = 2.08$, $p < .05$). In addition, a significantly greater percentage of 1989 vehicles had the horizontal aim of the right headlamp within SAE limits than 1987 vehicles ($z = 2.38$, $p < .05$).

Further analyses were conducted to examine the actual aim data with respect to differing state inspection policies (PMVI vs non-PMVI). A series of analyses of variance were conducted to compare the headlamp aim data of vehicles obtained from a PMVI state (Virginia) with that of a non-PMVI state (Maryland).

There was a statistically significant difference between states with respect to the vertical aim of left headlamps, $F(1, 727) = 15.99$, $p < .05$. Left headlamps of Maryland vehicles (mean = up .64 inches) were aimed significantly higher than were those of Virginia vehicles (mean = down .36 inches). The standard deviation for the vertical aim of Maryland vehicles (standard deviation = 3.54) was also slightly larger than that for Virginia vehicles (standard deviation = 3.25), indicating greater variation in the vertical aim readings for Maryland vehicles (see Table 10 below).

Table 10: Summary of headlamp aim data classified by state

STATE	LEFT LAMP VERTICAL AIM (inches) Mean (std dev.)	LEFT LAMP HORIZONTAL AIM (inches) Mean (std dev.)	RIGHT LAMP VERTICAL AIM (inches) Mean (std dev.)	RIGHT LAMP HORIZONTAL AIM (inches) Mean (std dev.)
Virginia (PMVI)	down .36 (3.25)	left .86 (2.55)	down .19 (3.15)	left 1.45 (2.77)
Maryland (non-PMVI)	up .65 (3.54)	left .79 (3.06)	up .65 (3.53)	left 1.27 (3.25)

There was also a statistically significant difference between states with respect to the vertical aim of the right headlamps, $F(1, 720) = 11.32$, $p < .05$. Right headlamps of vehicles from Maryland (mean = up .65 inches) were aimed significantly higher than were those of vehicles from Virginia (mean = down .19 inches). Again, the standard deviation for the aim of Maryland vehicles (standard deviation = 3.53) was greater than that for the aim of Virginia vehicles (standard deviation = 3.15), indicating greater variation in the vertical aim readings for Maryland vehicles (see Table 10 above).

Analyses of vertical aim data from our sample of vehicles indicate that vehicles from Maryland tend to have their headlamps aimed higher in the vertical plane than do Virginia vehicles. In addition, these analyses demonstrate a greater variability of vertical aim

readings for Maryland vehicles when compared with vertical aim readings from Virginia vehicles.

No statistically significant differences were found when examining Maryland and Virginia vehicles in terms of horizontal aim. As shown in Table 10 above, there was very little difference between states in terms of horizontal aim readings. However, the standard deviations of horizontal aim readings of Maryland vehicles were markedly larger than those of Virginia vehicles indicating greater variability of horizontal aim readings for Maryland vehicles.

Table 11 below provides comparative view of aim readings between states in terms of the percentage of vehicles from each state found to have headlamps aimed within SAE limits. As shown below, overall about 55% of Virginia vehicles had both lamps aimed within the limits of acceptability as compared with about 44% for Maryland vehicles. In all cases, Virginia vehicles had a higher percentage of acceptable headlamp aim than Maryland vehicles. These findings are consistent with those found in 1985 (see Olson & Winkler, 1985) when comparing a PMVI state with a non-PMVI state; the PMVI state having a consistently higher percentage of acceptable headlamp aim than the non-PMVI state. As compared with the 1985 NHTSA study (Olson & Winkler, 1985), the present study found about a 10% increase in aim compliance for the PMVI state and about a 6% increase in aim compliance for the non-PMVI state. Although different PMVI and non-PMVI states were used in the present study than in the 1985 study, these results are encouraging since they suggest a possible trend toward improved headlamp aim.

Table 11: Percent of vehicles having left, right, and both headlamps aimed within SAE limits (+-4 inches at 25 feet) in a PMVI state (Virginia) and a non-PMVI state (Maryland)

STATE	LEFT LAMP	RIGHT LAMP	BOTH LAMPS
Virginia (PMVI)	69.3%	69.0%	54.9%
Maryland (non-PMVI)	62.8%	57.0%	43.5%

Further analyses were performed to determine whether the differences in percentage of compliance shown above in Table 11 reached statistical significance. There was a borderline significant difference between states in terms of the percentage of vehicles found to have the left lamp aimed within SAE limits ($z = 1.90$ $p < .0574$); Virginia vehicles had a greater percentage of left lamps within SAE limits than Maryland vehicles. There was a significant difference between states with respect to the percentage of vehicles found to have the right lamp aimed within SAE limiits ($z = 3.43$, $p < .05$); again Virginia vehicles had a greater percentage aimed within standards than Maryland vehicles. In addition, there was a significant difference between states in terms of the percentage of vehicles having both lamps aimed within SAE limits ($z = 3.17$, $p < .05$); Virginia vehicles had a greater percentage aimed within standards (see Table 11 above).

Analyses of variance were also conducted to compare different vehicle types (cars, vans, light trucks, and utility vehicles) with respect to headlamp aim. Table 12 below displays the summary statistics for these analyses. There was a statistically significant difference between the vehicle types in terms of vertical aim of the left headlamp, $F (3, 724) = 10.71$, $p < .05$. The left headlamp of vans (mean = up 1.23 inches) and light trucks (mean = up 2.01 inches) were found to be aimed significantly higher than that of cars (mean = down .23 inches).

In addition, there was a statistically significant difference between vehicle types in terms of vertical aim of the right headlamp, $F (3, 717) = 8.15$, $p < .05$. The right headlamp of light trucks (mean = up 2.01 inches) was found to be aimed significantly higher than that of cars (mean = down .07 inches). There was not a statistically significant difference between the vertical aim of the right headlamp of cars and that of vans (as was found for the left headlamp); however as shown in Table 12 below, the difference was notably large. There was also a statistically significant difference between vehicle types in terms of vertical aim of the left headlamp, $F (3, 724) = 10.78$. $p < .05$. The left headlamp of vans (mean = up 1.23 inches) and light trucks (mean = up 2.01 inches) were found to be aimed significantly higher than that of cars (mean = down .23 inches).

Table 12: Summary of headlamp aim data classified by vehicle type

VEHICLE TYPE	LEFT LAMP VERTICAL AIM (inches)	LEFT LAMP HORIZONTAL AIM (inches)	RIGHT LAMP VERTICAL AIM (inches)	RIGHT LAMP HORIZONTAL AIM (inches)
	Mean (std dev.)	Mean (std dev.)	Mean (std dev.)	Mean (std dev.)
Cars	down .23 (3.33)	left .69 (2.72)	down .07 (3.36)	left 1.44 (2.89)
Vans	up 1.23 (2.70)	left 2.01 (2.60)	up .99 (2.54)	left .99 (3.25)
Light trucks	up 2.01 (3.99)	left 1.43 (3.40)	up 2.01 (3.63)	left 1.21 (3.01)
Utility Vehicle	up .80 (3.55)	left .61 (2.93)	up .56 (3.27)	left 1.15 (3.80)

There was also a significant difference between the different vehicle types in terms of horizontal aim of the left headlamp, $F(3, 728) = 4.50$, $p < .05$. The left headlamp of vans (mean = left 2.01 inches) was found to be aimed significantly further to the left than that of cars (mean = left .69 inches) and that of utility vehicles (mean = left .61 inches). Surprisingly, no significant differences were found between vehicle types for the horizontal aim of the right headlamp; all vehicle types were found to have their right headlamp aimed about the same extent to the left (see Table 12 above).

5.2.1.2 Analysis of secondary variables

In addition to the analyses presented above, correlational analyses were performed on all secondary data items related to headlamp aim in order to examine possible relationships between these variables and headlamp aim. A complete table of results of this analysis can be found in Appendix E.

There was no significant relationship between the number of months since headlamp inspection and headlamp aim indicating that, in general, the misaim of headlamps should not necessarily be expected to increase as the number of months since headlamp inspection increases. Since vehicles from Maryland (a non-PMVI state) are not required to undergo a complete annual inspection including headlamp testing, only vehicles from Virginia (a PMVI state) were addressed in this analysis. This type of analysis was not conducted in a recent NHTSA study (Olson & Winkler, 1985). However, this finding is consistent with findings from an earlier study (Hull et al., 1972) which reported no direct relationship between headlamp aim and the number of months since headlamp inspection.

There was also no significant relationship found between headlamp aim and odometer reading (total mileage). This is not surprising since there was no statistically significant difference between the headlamp aim of vehicles of various model years (see Table 7 on p. 5-4 above).

No significant relationship was found between headlamp aim and vehicle load. This suggests that the impact that load has on current model vehicles (1986 - present) may be offset by suspension accommodation so that headlamp aim is not significantly affected. This would be consistent with previous research which documents significant improvements over time with respect to effect of load on headlamp aim (Olson & Winkler, 1985).

A significant relationship was found between headlamp aim and the "looseness" of headlamps (i.e., whether lamps were anchored securely in the surrounding housing). Predictably, if a headlamp was loose, the tendency was for misaim to be greater than when a headlamp was not loose. In another maintenance-related analysis, there was no significant relationship between headlamp aim and the maintenance history of headlamps including whether the lamps had previously been replaced or aimed. It should be noted that the collection of these data completely depended upon the knowledge and cooperation of the driver of the vehicle (rather than direct measurement or observation), and in many cases the maintenance history of the headlamps was unknown. Therefore, this lack of finding may not be a reliable indication of whether headlamp maintenance is related to aim.

There was no significant relationship between headlamp aim and headlamp type, height of headlamp from the ground, or design of headlamp. These results suggest that, in general, headlamp aim was not directly affected by whether headlamps were retractable vs non-retractable, constructed of plastic vs glass lenses, sealed beam vs replaceable bulb type, mounted high vs low above the ground, or were manufactured by any particular company.

5.2.1.3 Supplementary analyses

CAE-Link scientists also examined two separate issues related to the headlamp aim. First, a small quantity of data (n = 15) were collected pertaining to the difference in headlamp aim due to fuel level. This addition to the study was conducted in order to ascertain whether weight difference caused by fuel level measurably affects headlamp aim. Using the same data collection methodology as was normally used, headlamp aim data were obtained before and after vehicles were fueled. The vehicles used in this measurement typically had less than a quarter tank of fuel prior to the first measurement and were then filled completely prior to the second measurement. Thus, data collectors were able to obtain headlamp aim measurements while vehicles had a low fuel level and then when they had a high fuel level. Results acquired from these data are shown in Table 13 below.

Table 13: Vertical aim difference after fueling

VERTICAL AIM DIFFERENCE (inches)	FREQUENCY
up 1.00	2
up .75	1
up .50	4
up .25	4
.00 (no change)	4

These data are comparable to those presented by Olson and Winkler (1985) in that they indicate relatively little change in aim due to variations in fuel level. As shown in Table 13 above, the largest change due to fuel level was 1 inch (up). The average difference in aim due to fuel level for this sample was .38 inches up. The sample size for this analysis was too small to draw a definite conclusion about the effect of fuel level on headlamp aim, but these data in conjunction with those reported by Olson & Winkler (1985) indicate that fuel level plays a minor role in headlamp aim. Appendix F displays a frequency table, histogram, and summary statistics for these data.

A second supplementary analysis was conducted on the use of a state-of-the-art Hopkins Fractional Balance Headlamp Aimer to collect headlamp data under the same field conditions as were used during the primary portion of the study. Unlike the Hopkins Mechanical Aimers used in this study, which estimate headlamp aim based on lens level, the Hopkins Fractional Balance Headlamp Aimer determines aim based on photometric characteristics. This device analyzes the beam pattern photometrically, defines where certain light intensities are in relation to one another, and then reports the position of the beam pattern as a whole. Using the fractional balance aimer, a small quantity of data (n = 22) were collected using the same methodology as was normally implemented. This addition to the study was conducted as a means of obtaining a sample of real world data using the fractional balance aimer and to determine the feasibility of collecting these data implementing the methodology executed in this study. Aim readings obtained using the fractional balance aimer are presented below together with the aim readings obtained from the same vehicles using the mechanical aimers (see Table 14 below).

Table 14: Headlamp aim determined using Hopkins Mechanical Aimers vs Fractional Balance Headlamp Aimer

MEASUREMENT DEVICE	LEFT LAMP VERTICAL AIM (inches)	LEFT LAMP HORIZONTAL AIM (inches)	RIGHT LAMP VERTICAL AIM (inches)	RIGHT LAMP HORIZONTAL AIM (inches)
	Mean (std dev.)	Mean (std dev.)	Mean (std dev.)	Mean (std dev.)
Mechanical Aimers	down .55 (1.89)	left .84 (2.46)	up .24 3.17)	right .27 (3.91)
Fractional Balance Aimer	down 2.49 (7.28)	left 6.37 (14.62)	down 1.27 (7.38)	left 7.56 (14.47)

As shown in Table 14 above, aim measurements varied as a function of measurement device. In accordance with both measurement devices, these data suggest that these vehicles were within the acceptable range for vertical aim, but were well beyond the acceptable range for horizontal aim (SAE headlamp aim limits = +- 4 inches vertically and horizontally). Appendix G displays frequency tables, histograms, and summary statistics for these data.

The mechanical aimer was the primary data collection instrument because the lamps measured were required by FMVSS 108 to be mechanically aimable. The accuracy of mechanical aimers is prescribed by SAE J602 as +- .5 inches vertically and +- 1 inch horizontally. Lamps are not required to be optically aimable. Therefore, fractional balance aimers that optically align the beam pattern may not necessarily be able to correctly measure aim.

5.2.2 Rear lighting system data

The rear lighting system data were analyzed following the removal of a small number of cases (10) found to be outliers. Only cases found to be misrecorded were removed. Complete frequency distributions, histograms, and summary statistics of the rear lighting system data are presented in Appendix H.

Analyses of the rear lighting system data are summarized in Table 15 below. These readings tend to be normally distributed although some items show relatively large standard deviations indicating a high degree of variation among readings.

Table 15: Summary of rear lighting system data

MEASUREMENT	MEAN	STD DEV.	MIN.-MAX.
Amps, Left Stoplamp, Low Idle	1.98	.18	1.06- 2.62
Amps, Left Stoplamp, High Idle	2.00	.17	1.06-2.62
Amps, Right Stoplamp, Low Idle	1.97	.15	1.30-2.55
Amps, Right Stoplamp, High Idle	1.99	.14	1.45-2.55
Volts, Left Stoplamp, Low Idle	11.88	1.09	8.47-14.20
Volts, Left Stoplamp, High Idle	12.30	.80	9.93-14.17
Volts, Right Stoplamp, Low Idle	11.87	1.10	8.50-14.10
Volts, Right Stoplamp, High Idle	12.27	.79	9.85-14.04
Amps, Left Presence, Low Idle	.52	.08	.26-.96
Amps, Left Presence, High Idle	.52	.08	.26-.97
Amps, Right Presence, Low Idle	.52	.08	.28-.94
Amps, Right Presence, High Idle	.52	.08	.28-.94
Volts, Left Presence, Low Idle	12.78	.82	10.32-14.19
Volts, Left Presence, High Idle	13.05	.61	10.82-14.21
Volts, Right Presence, Low Idle	12.74	.81	10.27-14.18
Volts, Right Presence, High Idle	13.03	.59	10.76-14.15
Amps, Left Turn Signal, Low Idle	2.14	.21	1.16-3.04
Amps, Left Turn Signal, High Idle	2.16	.20	1.20-3.04
Amps, Right Turn Signal, Low Idle	2.13	.17	1.68-3.04
Amps, Right Turn Signal, High Idle	2.15	.17	1.68-3.04
Volts, Left Turn Signal, Low Idle	11.79	.93	9.28-13.36
Volts, Left Turn Signal, High Idle	12.13	.66	9.96-13.36
Volts, Right Turn Signal, Low Idle	11.80	.91	9.32-13.82
Volts, Right Turn Signal, High Idle	12.14	.63	9.96-13.82
Volts, Battery, Low Idle	13.80	.73	11.10-14.80
Volts, Battery, High Idle	14.08	.42	12.12-14.81

As shown in Table 15 above, there was a noticeable drop in average voltage from the battery to the rear of the vehicle. This may be at least partially responsible for any unusually low voltage readings obtained at the rear of the vehicle (see section 5.2.2.1, p. 5-16 for discussion of differences between voltage readings obtained at the battery vs at the rear of the vehicle).

5.2.2.1 Analysis of primary variables

A series of analyses of variance was conducted on the rear lighting system data to examine the effect of vehicle age on the electrical performance characteristics (voltage and amperage). Because data were collected from only eight 1986 vehicles, these data were removed from analyses pertaining to vehicle age effects. The results of the analyses are discussed below.

There was no significant difference between different model year vehicles in terms of voltage readings at the left stoplamp at low idle. However, there was a significant effect of vehicle year with regard to voltage readings at the left stoplamp at *high* idle, F (5, 196) = 2.43, $p < .05$. As shown in Table 16 below, the 1991 vehicles had significantly higher voltage readings than the 1988 vehicles. There was no significant difference between vehicles of different model years in terms of voltage readings obtained at the right stoplamp at low or high idle. However, as shown in Table 16 below, a pattern of readings was found that is similar to those for the left stoplamp. There were no significant findings with respect to amperage readings.

Table 16: Mean voltage readings at stoplamps by vehicle model year

STOPLAMP	IDLE SPEED	1987	1988	1989	1990	1991
LEFT	LOW	11.81	11.57	12.17	11.76	12.00
	HIGH	12.19	11.96	12.44	12.27	12.56
RIGHT	LOW	11.93	11.55	12.12	11.74	11.93
	HIGH	12.18	11.96	12.35	12.26	12.47

As displayed in Table 17 below, there was a significant difference between vehicles of different model years with regard to voltage readings at the left presence lamp at low idle, F (5, 196) = 2.60, $p < .05$. The 1989 vehicles and the 1991 vehicles had significantly higher voltage readings than the 1988 vehicles. There was also a significant effect of vehicle year for voltage readings at the left presence lamp at high idle, F (5,196) = 4.59, $p < .05$. Again, the 1989 vehicles and the 1991 vehicles had significantly higher voltage readings than the 1988 vehicles. In addition, the 1991 vehicles had significantly higher voltage readings than the 1987 vehicles (see Table 17 below).

Table 17: Mean voltage readings at presence lamps by vehicle model year

PRESENCE LAMP	IDLE SPEED	1987	1988	1989	1990	1991
LEFT	LOW	12.65	12.43	12.95	12.71	13.04
	HIGH	12.86	12.73	13.14	13.09	13.34
RIGHT	LOW	12.61	12.44	12.91	12.69	12.98
	HIGH	12.81	12.78	13.07	13.05	13.31

No significant difference was found between vehicles of different model years with respect to voltage readings at the right presence lamp at low idle. However, there was a significant difference between vehicles of different model years with respect to voltage readings at the right presence lamp at *high* idle, F (5, 195) = 3.71, $p < .05$. The 1991 vehicles had significantly higher voltage readings than the 1987 and 1988 vehicles. Again, there were no significant findings with respect to amperage readings.

As shown in Table 18 below, there was also a significant effect of vehicle year for voltage readings at the left turn signal lamp at low idle, $F(5, 195) = 2.88$, $p < .05$. The 1989 vehicles had significantly higher voltage readings than the 1988 vehicles. In addition, there was a significant difference between vehicles of different model years in terms of voltage readings at the left turn signal lamp at high idle, $F(5, 195) = 3.72$, $p < .05$. In this case, the 1989 *and* 1991 vehicles had significantly higher voltage readings than the 1988 vehicles.

Table 18: Mean voltage readings for turn signal lamps by vehicle model year

TURN SIGNAL LAMP	IDLE SPEED	1987	1988	1989	1990	1991
LEFT	LOW	11.64	11.46	12.14	11.66	11.87
	HIGH	11.94	11.81	12.32	12.07	12.31
RIGHT	LOW	11.77	11.50	12.11	11.73	11.78
	HIGH	12.00	11.82	12.33	12.15	12.25

Similarly, there was a significant difference between vehicles of different model years for voltage readings at the right turn signal lamp at low idle, $F(5, 193) = 2.03$, $p < .05$. The 1989 vehicles had significantly higher voltage readings at the right signal lamp at low idle than the 1988 vehicles. Additionally, there was a significant difference between vehicles of different model years for voltage readings at the right turn signal lamp at high idle, $F(5, 193) = 3.29$, $p < .05$. This time, the 1989 *and* 1991 vehicles had significantly higher voltage readings than the 1988 vehicles. There were no significant findings in these analyses with respect to amperage readings.

There was no significant effect of vehicle year on the voltage readings obtained at the battery at low idle speed. However, there was a significant effect of vehicle year on voltage at the battery at *high* idle, $F(5, 193) = 2.77$, $p < .05$. The 1990 vehicles had significantly higher voltage than the 1988 vehicles. This may at least partially explain the consistent effects of vehicle year addressed above.

In general, the analyses examining the effect of vehicle year on electrical performance characteristics demonstrate a tendency for newer vehicles to have higher voltage readings at the stoplamps, presence lamps, turn signal lamps, and at the battery. The finding that some newer vehicles have higher voltage readings than some older vehicles

at the battery is notable since this directly affects the power available to the rear lighting system. However, since the trend was not found across all vehicles sampled, this cannot be considered the complete explanation.

Analyses of variance were also conducted on the rear lighting system data to examine the effect of vehicle type on the voltage and amperage readings. Due to the small number of observations of vans, light trucks, and utility vehicles, respectively, data from these vehicles were classified as a single group of observations. Thus, for the purpose of this series of analyses, a vehicle was categorized as either a: 1) car, or 2) van, pickup, or utility vehicle.

There was a significant effect of vehicle type with respect to the voltage readings at the left stoplamp at low idle, $F(1, 200) = 67.39$, $p < .05$, and at high idle, $F(1, 200) = 62.03$, $p < .05$. In addition, a significant effect of vehicle type was found for the voltage readings at the right stoplamp at low idle, $F(1, 199) = 62.27$, $p < .05$, as well as at high idle, $F(1, 199) = 52.06$, $p < .05$. As shown in Table 19 below, cars were found to have significantly lower voltage readings than vans, light trucks, and utility vehicles at the left and right stoplamps at both idle speeds.

Table 19: Mean voltage readings at stoplamps by vehicle type

STOPLAMP	IDLE SPEED	CARS	OTHERS*
LEFT	LOW	11.57	12.84
	HIGH	12.08	12.99
RIGHT	LOW	11.57	12.81
	HIGH	12.06	12.90

* Including vans, light trucks, and utility vehicles

There was a significant effect of vehicle type for voltage readings at the left presence lamp at low idle, $F(1, 200) = 29.23$, $p < .05$, and at high idle, $F(1, 200) = 22.60$, $p < .05$. Likewise, there was a significant effect of vehicle type for voltage readings at the right presence lamp at low idle, $F(1, 199) = 29.18$, $p < .05$, as well as at high idle, $F(1, 199) = 20.10$, $p < .05$. As shown in Table 20 below, cars had significantly lower voltage readings than vans, light trucks, and utility vehicles at the left and right presence lamps at both idle speeds. Again, there were no significant findings in these analyses with respect to amperage readings.

Table 20: Mean voltage readings at presence lamps by vehicle type

PRESENCE LAMP	IDLE SPEED	CARS	OTHERS*
LEFT	LOW	12.61	13.29
	HIGH	12.95	13.39
RIGHT	LOW	12.58	13.25
	HIGH	12.92	13.02

* Including vans, light trucks, and utility vehicles

There was also a significant effect of vehicle type for voltage readings at the left turn signal lamp at low idle, $F(1, 199) = 39.11$, $p < .05$, and at high idle, $F(1, 199) = 34.32$, $p < .05$. In addition, a significant effect of vehicle type was found for the voltage readings at the right turn signal lamp at low idle, $F(1, 197) = 34.45$, $p < .05$, and at high idle, $F(1,197) = 28.59$, $p < .05$. As displayed in Table 21 below, cars were found to have significantly lower voltage readings than van, light trucks, and utility vehicles at the left and right turn signal lamps at both idle speeds.

Table 21: Mean voltage readings at turn signal lamps by vehicle type

TURN SIGNAL LAMP	IDLE SPEED		
		CARS	OTHERS*
LEFT	LOW	11.57	12.44
	HIGH	11.98	12.56
RIGHT	LOW	11.60	12.43
	HIGH	12.01	12.54

* Including vans, light trucks, and utility vehicles

Interestingly, there was a significant effect of vehicle type for voltage readings obtained at the battery at low idle, F (1, 198) = 15.35, $p < .05$, and at high idle, F (1, 197) = 21.23, $p < .05$. Cars were found to have significantly lower voltage readings than vans, light trucks, and utility vehicles at the battery at low and high idle. This finding may at least partially explain the consistently lower voltage readings obtained from the rear lighting systems of cars relative to vans, light trucks, and utility vehicles.

In general, the analyses examining the effect of vehicle type on electrical performance characteristics show that the group of cars that were sampled have distinctly different voltage readings compared with the group consisting of vans, light trucks, and utility vehicles. As displayed in the tables above, cars had lower voltage readings than vans, light trucks, and utility vehicles at the stoplamps, presence lamps, turn signal lamps, and at the battery at both idle speeds. The most critical finding may be that cars generally had lower voltage at the battery; thus having less power available to the rear lighting system.

5.2.2.2 Analysis of secondary variables

In addition to the analyses presented above, correlational analyses were performed on all secondary data items related to the rear lighting system in order to examine the relationships between variables and the electrical performance of the rear lighting system. A complete table of results of the correlational analyses can be found in Appendix I.

There was no significant relationship between the air temperature at the time of data collection and any of the electrical performance measurements. This indicates that there were no significant differences between electrical performance readings as a result of variations in air temperature.

Although there was no significant correlation between vehicle length and voltage readings obtained at the rear lighting system, there was a significant relationship between vehicle length and voltage readings obtained at the battery at both low and high idle. Higher voltage readings at the battery were associated with longer vehicles. This correlation seems plausible since it was found that cars had lower voltage readings than vans, light trucks, and utility vehicles at the battery (see discussion in section 5.2.2.1, p. 5-19 above), and since cars are generally shorter in length than vans, light trucks, and utility vehicles.

A significant relationship was found between the number of bulbs per rear lamp assembly and voltage readings obtained at the stoplamps at both idle speeds. Vehicles with a greater number of bulbs per lamp were found to have lower voltage readings. The same relationship existed with respect to voltage readings obtained from the left presence lamp, the left turn signal lamp, and the right turn signal lamp at high idle; a greater number of bulbs per lamp significantly associated with lower voltage readings.

5.2.2.3 Supplementary analyses

CAE-Link scientists also examined how electrical performance data collected in the field would translate into photometric performance (luminous intensity) of a rear lighting system. In conjunction with NHTSA personnel, a stoplamp voltage reading (voltage = 10.42) in the lower fifth percentile was identified from the data collected. A photometric test was conducted using NHTSA/SAE procedures to determine how this atypically low voltage reading would translate into photometric performance of the stoplamp. As a means of comparison, a photometric test was also conducted using the voltage determined by using NHTSA/SAE procedures (voltage = 12.9) and using an intermediate voltage (voltage = 11.64).

Table 22 below displays a summary of the photometric testing in terms of the standard angles at which intensities were recorded. As shown in Table 22 below, when using the selected field voltage value of 10.42, several stoplamp intensities were lower than the intensities specified in NHTSA requirements, which are applicable to new lamps which are tested at voltages prescribed by various SAE test procedures. NHTSA also prescribes alternative minimum intensity requirements that are the sum of intensities for groups of test points, which are defined in FMVSS 108, Figure 1c. The intensities measured at the field voltage were also lower than these grouped minimum candlepower requirements. In contrast, stoplamp intensities were greater than the lower limits specified by NHTSA FMVSS 108 at all angles when the test voltage specified for the lamp and the intermediate voltage were used.

Table 22: Results of photometric testing based on selected field voltage, NHTSA/SAE test voltage, and intermediate voltage

ANGLE (deg)		MINIMUM LUMINOUS INTENSITY (cd)			
Vertical	Horizontal		Test Voltage (12.9 volts)	Intermediate Voltage (11.64 volts)	Selected Field Voltage (10.42 volts)
10 up	5 left	19	94	64	45
10 up	5 right	19	90	61	43
5 up	20 left	12	66	46	32
5 up	10 left	36	114	79	55
5 up	0	83	153	107	74*
5 up	10 right	36	109	76	53
5 up	20 right	12	69	48	33
0	10 left	47	129	90	62
0	5 left	95	156	108	75*
0	0	95	170	119	83*
0	5 right	95	145	101	70*
0	10 right	47	115	81	56
5 down	20 left	12	75	53	37
5 down	10 left	36	121	85	59
5 down	0	83	149	105	73*
5 down	10 right	36	116	81	56
5 down	20 right	12	78	54	38
10 down	5 left	19	94	66	46
10 down	5 right	19	95	67	46

* Indicates failure of lamp at that testing angle

The raw data from the photometric testing laboratory are presented in Appendix J. The field voltage reading selected for photometric testing is representative of the lower 5th percentile of voltage readings obtained at the stoplamp at low idle. Thus, based solely on the field voltage data, several other vehicles in the sample may have produced similar photometric results. This raises the possibility that a number of vehicles may be operating with rear lamp luminous intensity levels below values required by the NHTSA standard, which specifies lamp measurements under laboratory conditions.

APPENDIX A

HEADLIGHT ALIGNMENT
SAMPLE SIZE JUSTIFICATION

HEADLIGHT ALIGNMENT
SAMPLE SIZE JUSTIFICATION

Using vehicle registration data obtained from R.L. Polk and Company via NHTSA, the total number of registered cars and trucks in Maryland and Virginia manufactured from 1986-present was established. Having these data provided a basis for calculating the required sample size for each state. A second tool used for this exercise was a popular reference book for survey research entitled "Introduction to Survey Sampling, No. 07-035, Sage Publications (Kalton, 1984). This publication details how to determine a representative sample size if the actual population size is known.

In doing the calculations, it was assumed that a sample size should be determined separately for Maryland and Virginia. This assumption was made because there is reason to believe that registered Maryland vehicles and registered Virginia vehicles may differ with respect to headlight aim due to differences in vehicle inspection policies (see DOT HS-806-918, 1985; DOT HS-800 739, 1972). In accordance with previous research showing PMVI states tending to have better headlamp aim than non-PMVI states, it was hypothesized that Virginia (a PMVI state) would have significantly better headlamp aim than Maryland (a non-PMVI state).

The approach shown below is one that is often used when there is uncertainty about sample size (i.e., when a study is not a direct replication or when the actual population size is known to be very large as in the present study). This approach is provided by Kalton (1984) in the publication mentioned above. The first step is to calculate n' which is a correction factor for a finite population:

$$n' = Z^2 * PQ/X^2$$

The alpha level must then be determined (usually .05 is adopted) so that Z can be calculated. Next, the level of estimator precision is decided (+- 5% is suggested). The level of estimator precision refers to how far scores will be allowed to deviate from central tendency. Last, proportions P and Q must be determined. These refer to the proportion of cases that are expected to fall in a given category or another. If there is no reason to factor proportions in to the calculation, P=50% and Q=50% should be used to provide the most conservative estimate.

In the present case, it was decided that alpha should equal .05, the Z score associated with this is 1.96, and 3.845 when squared in the calculation. If there is no reason to factor in proportions of any kind, then P=50% and Q=50% are used; and thus PQ=.25. The level of precision of the estimator is commonly +-5% (and .05 squared equals .0025) so that value may be adopted. Applying these values to solve for n':

$n' = 3.845 * (.5)(.5)/.0025$

$n' = 384.5$

Since n' is now established, the actual population size for Maryland and Virginia must be determined, and then these two values are used to determine the sample size needed for the study. The following formula is used to find n (the required sample size for a given actual population N):

$$n = (Nn')/(N+n')$$

The value for n' has already been determined above and now all that is needed is the actual population size for Maryland and Virginia. In this case, the total number of vehicles currently registered including models from 1986-present must be established. According to vehicle registration data obtained from R.L. Polk and Company via NHTSA, the most current figures for each state are as follows:

Maryland:	1,579,494
Virginia:	1,954,645

Thus, N= 1,579,494 together with n' (n'=384.5) are used to solve for the Maryland sample size and N= 1,954,645 together with n' are used to solve for the Virginia sample size. Solving for n for each state:

Maryland $n = (1,579,494)(384.5)/(1,579,494) + (384.5)$

$n = 384.4$

Virginia $n = (1,954,645)(384.5)/(1,954,645) + (384.5)$

$n = 384.5$

Since this approach is assuming that Maryland and Virginia should be expected to differ in terms of headlight aim because of inspection policy (as shown in DOT HS-806-918, 1985; DOT HS-800 739, 1972)), n has been obtained separately for each state. That is, the required sample size for Maryland is 384.4, and the required sample size for Virginia is 384.4. Thus, under the conditions presented above, a conservative estimate of total sample size for this study is 768.8. It is not unusual for the condition to occur in which n'=n particularly when the population size is very large. To supplement this approach, enclosed is a copy of the table used to quickly estimate sample size for simple random sampling when the population size is known.

TARGET POPULATION AND SAMPLE SIZE

Degree of Accuracy = ±.05		Proportion of Sample Size = .05		Confidence Level = 95%	
Population	Sample	Population	Sample	Population	Sample
10	9	230	144	1400	301
15	14	240	147	1500	305
20	19	250	151	1600	909
25	23	260	155	1700	313
30	27	270	158	1800	316
35	32	280	162	1900	319
40	36	290	165	2000	322
45	40	300	168	2200	327
50	44	320	174	2400	331
55	48	340	180	2600	334
60	52	360	186	2800	337
65	55	380	191	3000	340
70	59	400	196	3500	346
75	62	420	200	4000	350
80	66	440	205	4500	354
85	69	460	209	5000	356
90	73	480	213	6000	361
95	76	500	217	7000	364
100	79	550	226	8000	366
110	85	600	234	9000	368
120	91	650	241	10000	369
130	97	700	248	15000	374
140	102	750	254	20000	376
150	108	800	256	30000	379
160	113	850	264	40000	380
170	118	900	269	50000	381
180	122	950	273	60000	381
190	127	1000	277	70000	382
200	131	1100	284	120000	382
210	136	1200	291	160000	383
220	140	1300	296	1000000	383

APPENDIX B

HEADLAMP AIM
DATA COLLECTION FORM

HEADLAMP AIM
DATA COLLECTION FORM

Date:_____ Location:_____
License Plate: VA MD Inspection Date: _____ N/A

1. Vehicle Type: car van pickup utility vehicle
Make:_____ Model_____ Year_____

2. Odometer Reading (miles):_____

3. Were lamps/bulbs ever replace?
rt yes no by whom: Self State inspector Other Unkn.
lf yes no by whom: Self State inspector Other Unkn.

4. Were lamps ever aimed?
rt yes no by whom: Self State inspector Other Unkn.
lf yes no by whom: Self State inspector Other Unkn.

5. Status of Fuel Gauge:_____

6. Estimated Vehicle Load (incl. passengers):_____

7. VIN Number:_____

8. Lamps are: Retractable yes no; rt plastic glass
lf plastic glass

9. Lamp Type: Sealed Beam Repl. Bulb Type Integral Type

10. Headlamp Mfg/Make/Model rt_____
lf_____

11. Lamp Mounting Height (from center of lamp):_____

12. Observed Condition of Headlights:

Moisture in lamp:	rt	yes	no	Reflector damage:	rt	yes	no
	lf	yes	no		lf	yes	no
Broken lens:	rt	yes	no	Rotated fr. norm.	rt	yes	no
	lf	yes	no	upright position:	lf	yes	no
Loose in housing:	rt	yes	no	Lens dirt:	rt	light med. heavy	
	lf	yes	no		lf	light med. heavy	

13. Aim Adapter Readings:_____

14. Alignment of Left Headlight: **vertical** / **horizontal**
_____/_____

15. Alignment of Right Headlight: **vertical** / **horizontal**
_____/_____

APPENDIX C

REAR LIGHTING SYSTEM MEASUREMENT DATA COLLECTION FORM

REAR LIGHTING SYSTEM MEASUREMENT
DATA COLLECTION FORM

1. Vehicle Type: car van pickup utility vehicle

   Make:_____ Model_____ Year_____

2. Odometer Reading (miles):_____

3. Make/Model of Stop, Presence, and Turn Signal Lamps:
   Stop: _____
   Presence: _____
   Turn Signal: _____

3. Lens markings of Stop, Presence, and Turn Signal Lamps:
   Stop: _____
   Presence: _____
   Turn Signal: _____

4. Amperage and Voltage at Stop, Presence, and Signal Lamps:

STOP LAMPS

Left Rear	low idle / high idle	Right Rear	low idle / high idle
Amps:	_____ / _____	Amps:	_____ / _____
Volts:	_____ / _____	Volts:	_____ / _____

PRESENCE LAMPS

Left Rear	low idle / high idle	Right Rear	low idle / high idle
Amps:	_____ / _____	Amps:	_____ / _____
Volts:	_____ / _____	Volts:	_____ / _____

TURN SIGNAL LAMPS

Left Rear	low idle / high idle	Right Rear	low idle / high idle
Amps:	_____ / _____	Amps:	_____ / _____
Volts:	_____ / _____	Volts:	_____ / _____

5. Volts at Battery
   low idle / high idle

   Volts:_____ / _____

6. Ambient Air Temp.:_____

7. Length of Vehic.:_____

8. Number of bulbs per brakelamp per side: _____
9. Number of bulbs per presence lamp per side: _____
10. Number of bulbs per turn signal lamp per side: _____
11. Arrangement of stoplights, presence lights, and turn signal lights:
    _____
    _____
12. Are turn signals amber? yes no
13. Comments:_____

Date:_____ Location:_____

APPENDIX D

HEADLIGHT ALIGNMENT
FREQUENCY TABLES, HISTOGRAMS, AND SUMMARY STATISTICS

HEADLIGHT ALIGNMENT
FREQUENCY TABLES, HISTOGRAMS, AND SUMMARY STATISTICS

VERTICAL AIM OF LEFT LAMP*

Value	Frequency	Percent	Valid Percent	Cum Percent
-10.00	2	.3	.3	.3
-9.50	1	.1	.1	.4
-9.00	3	.4	.4	.8
-8.50	2	.3	.3	1.1
-8.00	8	1.1	1.1	2.2
-7.50	3	.4	.4	2.6
-7.00	3	.4	.4	3.0
-6.50	2	.3	.3	3.3
-6.00	11	1.5	1.5	4.8
-5.50	9	1.2	1.2	6.0
-5.00	6	.8	.8	6.9
-4.50	13	1.8	1.8	8.6
-4.00	35	4.8	4.8	13.4
-3.50	16	2.2	2.2	15.6
-3.00	47	6.4	6.4	22.1
-2.50	25	3.4	3.4	25.5
-2.00	56	7.7	7.7	33.2
-1.75	1	.1	.1	33.3
-1.50	27	3.7	3.7	37.0
-1.25	1	.1	.1	37.2
-1.00	60	8.2	8.2	45.4
-.75	2	.3	.3	45.7
-.50	30	4.1	4.1	49.8
-.25	1	.1	.1	49.9
.00	60	8.2	8.2	58.2
.25	3	.4	.4	58.6
.50	30	4.1	4.1	62.7
.75	3	.4	.4	63.1
1.00	42	5.8	5.8	68.9
1.50	28	3.8	3.8	72.7
1.75	1	.1	.1	72.8
2.00	27	3.7	3.7	76.5
2.25	1	.1	.1	76.7
2.50	25	3.4	3.4	80.1
3.00	32	4.4	4.4	84.5
3.50	17	2.3	2.3	86.8
3.75	1	.1	.1	87.0
4.00	19	2.6	2.6	89.6
4.50	12	1.6	1.6	91.2
5.00	12	1.6	1.6	92.9

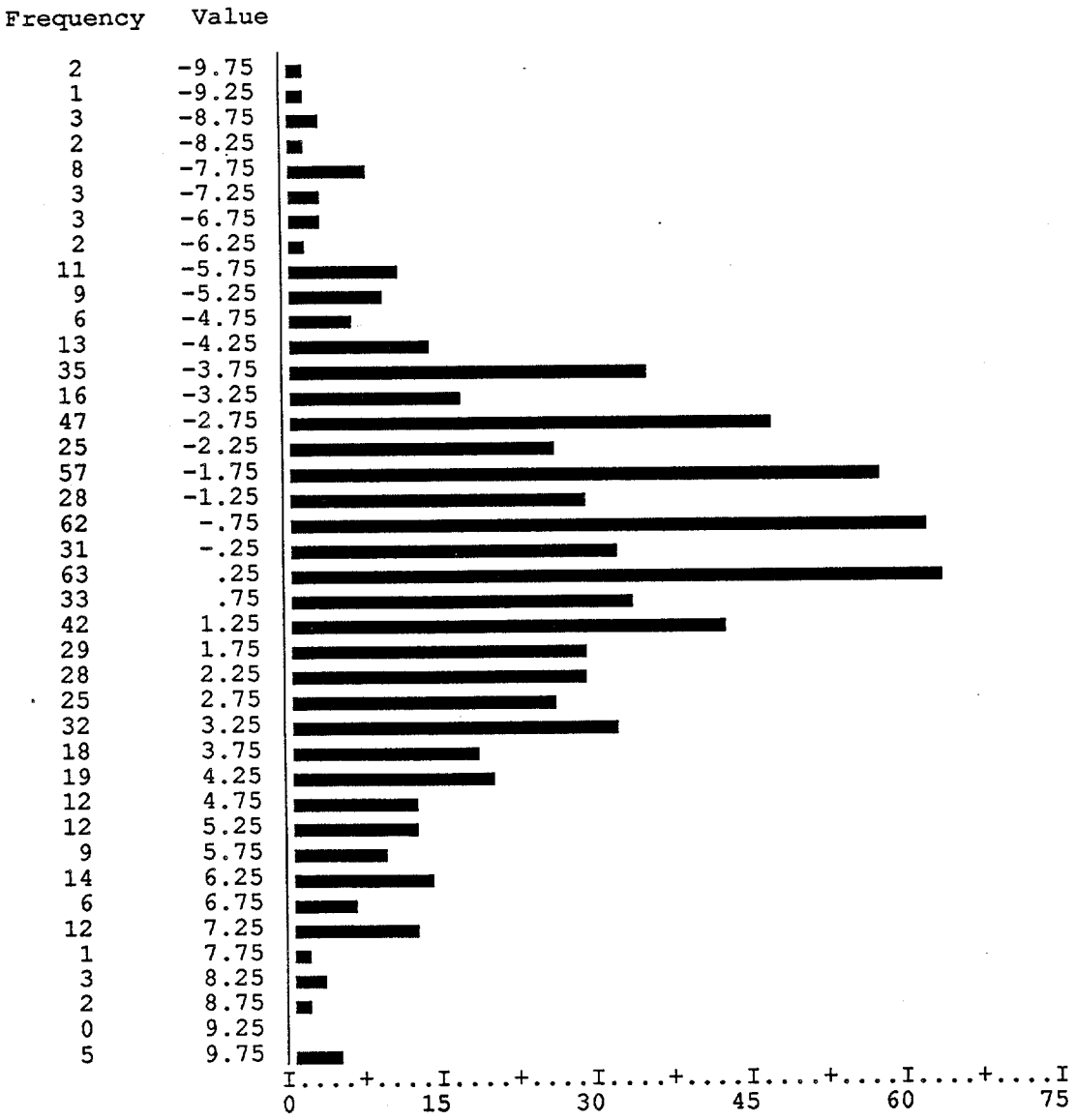
*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

VERTICAL AIM OF LEFT LAMP (continued)*

Value	Frequency	Percent	Valid Percent	Cum Percent
5.50	9	1.2	1.2	94.1
6.00	14	1.9	1.9	96.0
6.50	6	.8	.8	96.8
7.00	12	1.6	1.6	98.5
7.50	1	.1	.1	98.6
8.00	3	.4	.4	99.0
8.50	2	.3	.3	99.3
9.50	3	.4	.4	99.7
10.00	2	.3	.3	100.0
TOTAL	729	100.0	100.0	

*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

VERTICAL AIM OF LEFT LAMP (continued)*



*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

Mean	-.143	Std Err	.127	Median	.000
Mode	-1.000	Std Dev	3.432	Variance	11.779
Kurtosis	.199	S E Kurt	.181	Skewness	.127
S E Skew	.091	Range	20.000	Minimum	-10.000
Maximum	10.000	Sum	-104.500		

HORIZONTAL AIM OF LEFT LAMP*

Value	Frequency	Percent	Valid Percent	Cum Percent
-10.00	4	.5	.5	.5
-9.50	2	.3	.3	.8
-9.00	3	.4	.4	1.2
-8.00	3	.4	.4	1.6
-7.50	1	.1	.1	1.8
-7.00	2	.3	.3	2.0
-6.50	1	.1	.1	2.2
-6.00	7	1.0	1.0	3.1
-5.75	1	.1	.1	3.3
-5.50	5	.7	.7	4.0
-5.00	19	2.6	2.6	6.5
-4.50	19	2.6	2.6	9.1
-4.25	1	.1	.1	9.3
-4.00	27	3.7	3.7	13.0
-3.75	1	.1	.1	13.1
-3.50	13	1.8	1.8	14.9
-3.00	45	6.1	6.1	21.0
-2.50	36	4.9	4.9	25.9
-2.25	2	.3	.3	26.2
-2.00	68	9.3	9.3	35.5
-1.75	4	.5	.5	36.0
-1.50	49	6.7	6.7	42.7
-1.25	2	.3	.3	43.0
-1.00	79	10.8	10.8	53.8
-.75	1	.1	.1	53.9
-.50	56	7.6	7.6	61.5
-.25	1	.1	.1	61.7
.00	74	10.1	10.1	71.8
.50	24	3.3	3.3	75.0
1.00	46	6.3	6.3	81.3
1.50	20	2.7	2.7	84.0
1.75	4	.5	.5	84.6
2.00	32	4.4	4.4	88.9
2.50	21	2.9	2.9	91.8
3.00	12	1.6	1.6	93.5
3.50	7	1.0	1.0	94.4
4.00	10	1.4	1.4	95.8
4.50	6	.8	.8	96.6
5.00	6	.8	.8	97.4
5.50	2	.3	.3	97.7
6.00	4	.5	.5	98.2

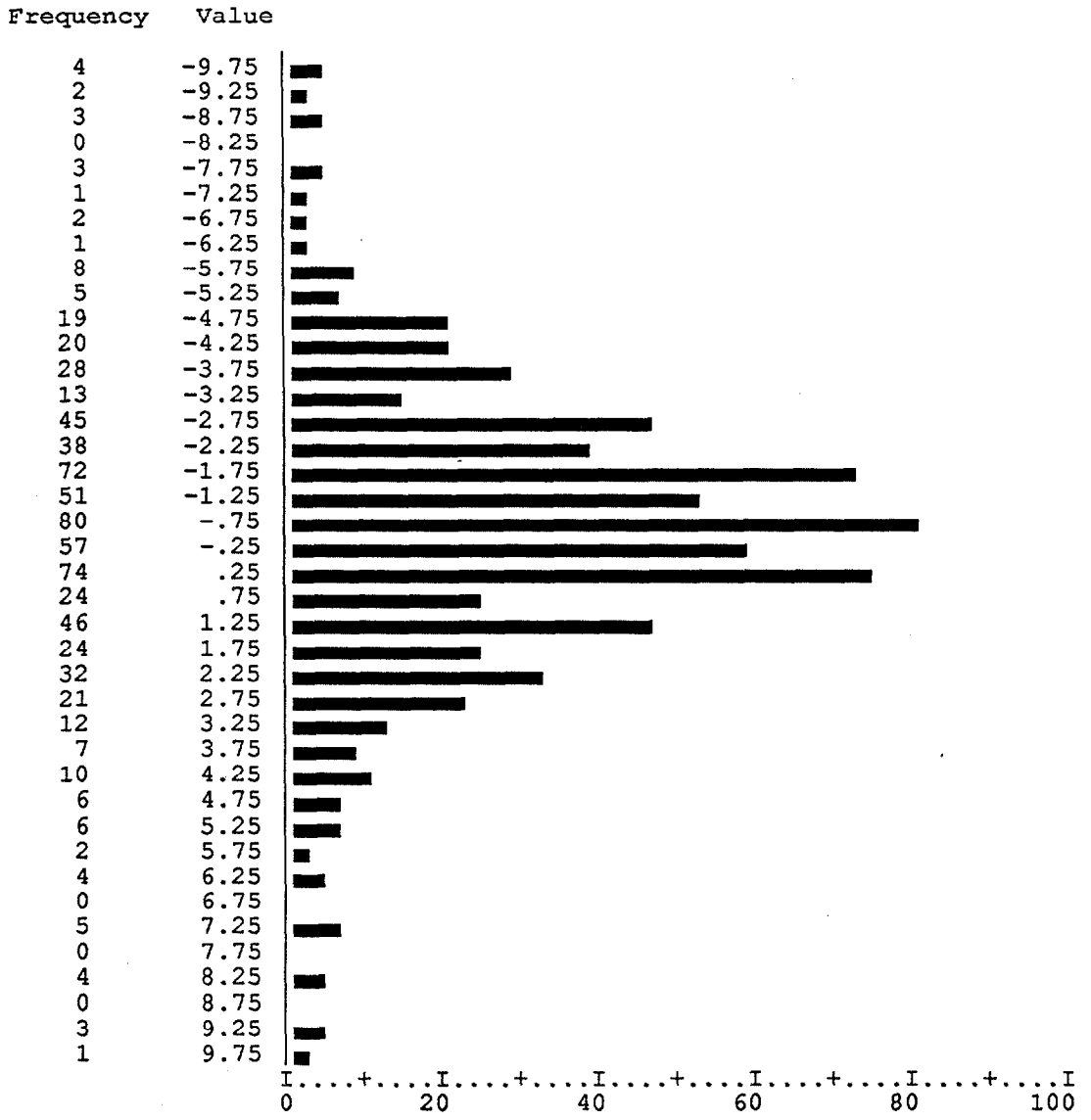
*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

HORIZONTAL AIM OF LEFT LAMP (continued)*

Value	Frequency	Percent	Valid Percent	Cum Percent
7.00	5	.7	.7	98.9
8.00	4	.5	.5	99.5
9.00	3	.4	.4	99.9
9.50	1	.1	.1	100.0
TOTAL	733	100.0	100.0	

*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

HORIZONTAL AIM OF LEFT LAMP (continued)*



*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

Mean	-.824	Std Err	.104	Median	-1.000
Mode	-1.000	Std Dev	2.814	Variance	7.920
Kurtosis	1.634	S E Kurt	.180	Skewness	.217
S E Skew	.090	Range	19.500	Minimum	-10.000
Maximum	9.500	Sum	-604.250		

VERTICAL AIM OF RIGHT LAMP*

Value	Frequency	Percent	Valid Percent	Cum Percent
-10.00	2	.3	.3	.3
-9.50	1	.1	.1	.4
-9.00	2	.3	.3	.7
-8.50	5	.7	.7	1.4
-8.00	3	.4	.4	1.8
-7.50	1	.1	.1	1.9
-7.00	8	1.1	1.1	3.0
-6.50	3	.4	.4	3.5
-6.25	1	.1	.1	3.6
-6.00	4	.6	.6	4.2
-5.75	1	.1	.1	4.3
-5.50	4	.6	.6	4.8
-5.00	15	2.1	2.1	6.9
-4.50	23	3.2	3.2	10.1
-4.25	1	.1	.1	10.2
-4.00	27	3.7	3.7	14.0
-3.50	19	2.6	2.6	16.6
-3.00	42	5.8	5.8	22.4
-2.50	27	3.7	3.7	26.2
-2.25	3	.4	.4	26.6
-2.00	56	7.8	7.8	34.3
-1.50	35	4.8	4.8	39.2
-1.25	3	.4	.4	39.6
-1.00	57	7.9	7.9	47.5
-.50	34	4.7	4.7	52.2
-.25	1	.1	.1	52.4
.00	47	6.5	6.5	58.9
.25	1	.1	.1	59.0
.50	25	3.5	3.5	62.5
.75	3	.4	.4	62.9
1.00	37	5.1	5.1	68.0
1.25	1	.1	.1	68.1
1.50	28	3.9	3.9	72.0
1.75	1	.1	.1	72.2
2.00	36	5.0	5.0	77.1
2.25	1	.1	.1	77.3
2.50	30	4.2	4.2	81.4
3.00	29	4.0	4.0	85.5
3.50	11	1.5	1.5	87.0
4.00	24	3.3	3.3	90.3
4.50	13	1.8	1.8	92.1
5.00	12	1.7	1.7	93.8
5.50	10	1.4	1.4	95.2
6.00	9	1.2	1.2	96.4

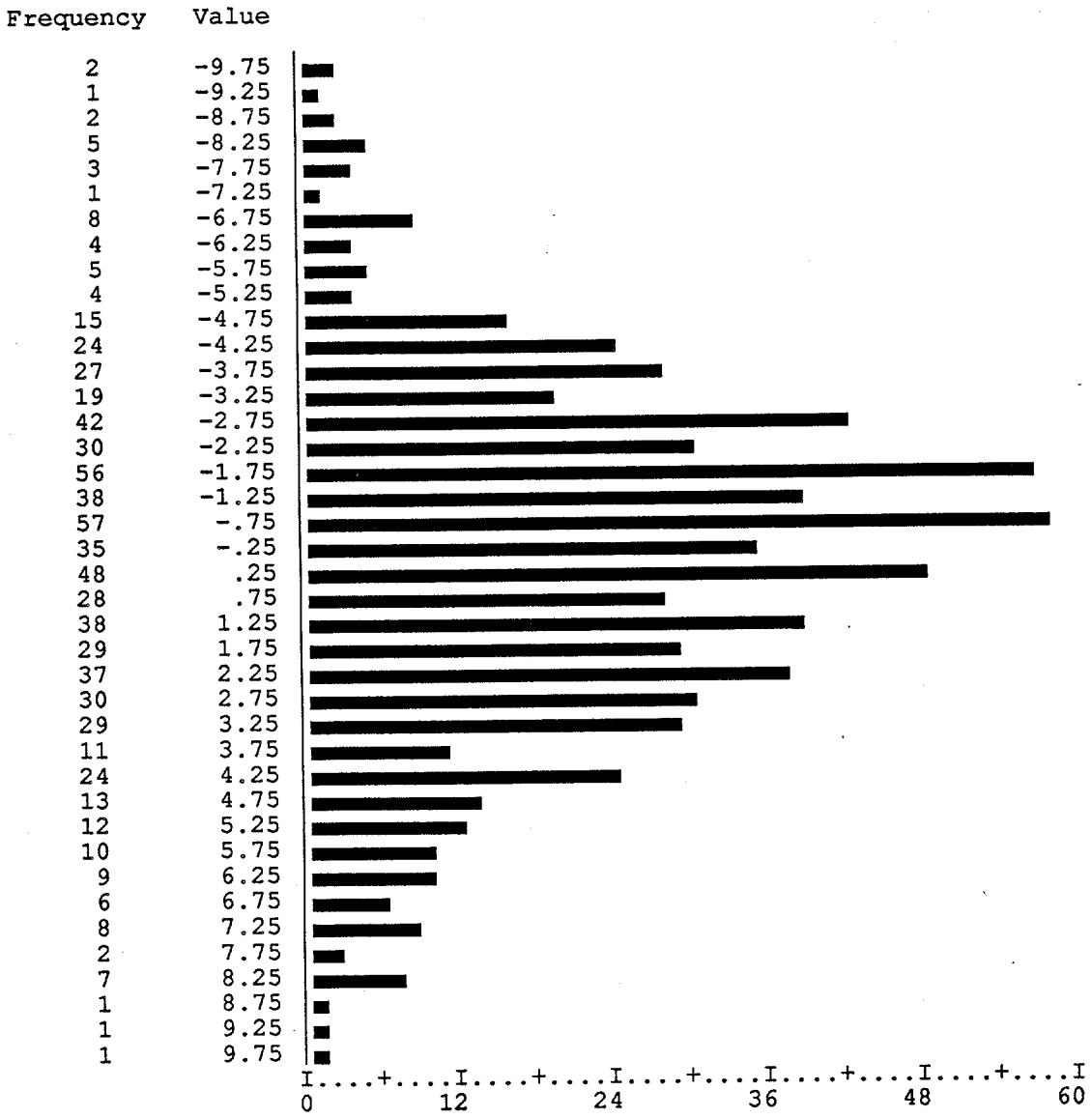
*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

VERTICAL AIM OF RIGHT LAMP (continued)*

Value	Frequency	Percent	Valid Percent	Cum Percent
6.50	6	.8	.8	97.2
7.00	8	1.1	1.1	98.3
7.50	2	.3	.3	98.6
8.00	7	1.0	1.0	99.6
8.50	1	.1	.1	99.7
9.00	1	.1	.1	99.9
9.50	1	.1	.1	100.0
TOTAL	722	100.0	100.0	

*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

VERTICAL AIM OF RIGHT LAMP (continued)*



*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

Mean	-.231	Std Err	.126	Median	-.500
Mode	-1.000	Std Dev	3.374	Variance	11.381
Kurtosis	.056	S E Kurt	.182	Skewness	.109
S E Skew	.091	Range	19.500	Minimum	-10.000
Maximum	9.500	Sum	-166.750		

HORIZONTAL AIM OF RIGHT LAMP*

Value	Frequency	Percent	Valid Percent	Cum Percent
-10.00	5	.7	.7	.7
-9.50	4	.5	.5	1.2
-9.00	2	.3	.3	1.5
-8.50	2	.3	.3	1.8
-8.00	8	1.1	1.1	2.9
-7.50	5	.7	.7	3.6
-7.00	9	1.2	1.2	4.8
-6.50	5	.7	.7	5.5
-6.00	2	.3	.3	5.8
-5.50	13	1.8	1.8	7.6
-5.00	17	2.3	2.3	9.9
-4.50	24	3.3	3.3	13.2
-4.00	32	4.4	4.4	17.6
-3.75	1	.1	.1	17.7
-3.50	29	4.0	4.0	21.7
-3.25	2	.3	.3	22.0
-3.00	53	7.3	7.3	29.3
-2.75	1	.1	.1	29.4
-2.50	37	5.1	5.1	34.5
-2.25	1	.1	.1	34.6
-2.00	74	10.2	10.2	44.8
-1.75	2	.3	.3	45.1
-1.50	51	7.0	7.0	52.1
-1.25	3	.4	.4	52.5
-1.00	71	9.8	9.8	62.2
-.75	1	.1	.1	62.4
-.50	45	6.2	6.2	68.5
-.25	1	.1	.1	68.7
.00	51	7.0	7.0	75.7
.25	2	.3	.3	76.0
.50	30	4.1	4.1	80.1
1.00	33	4.5	4.5	84.6
1.50	19	2.6	2.6	87.2
2.00	31	4.3	4.3	91.5
2.25	1	.1	.1	91.6
2.50	12	1.6	1.6	93.3
3.00	11	1.5	1.5	94.8
3.50	3	.4	.4	95.2
4.00	8	1.1	1.1	96.3
4.25	1	.1	.1	96.4
4.50	5	.7	.7	97.1
5.00	3	.4	.4	97.5
5.50	1	.1	.1	97.7
6.00	2	.3	.3	97.9

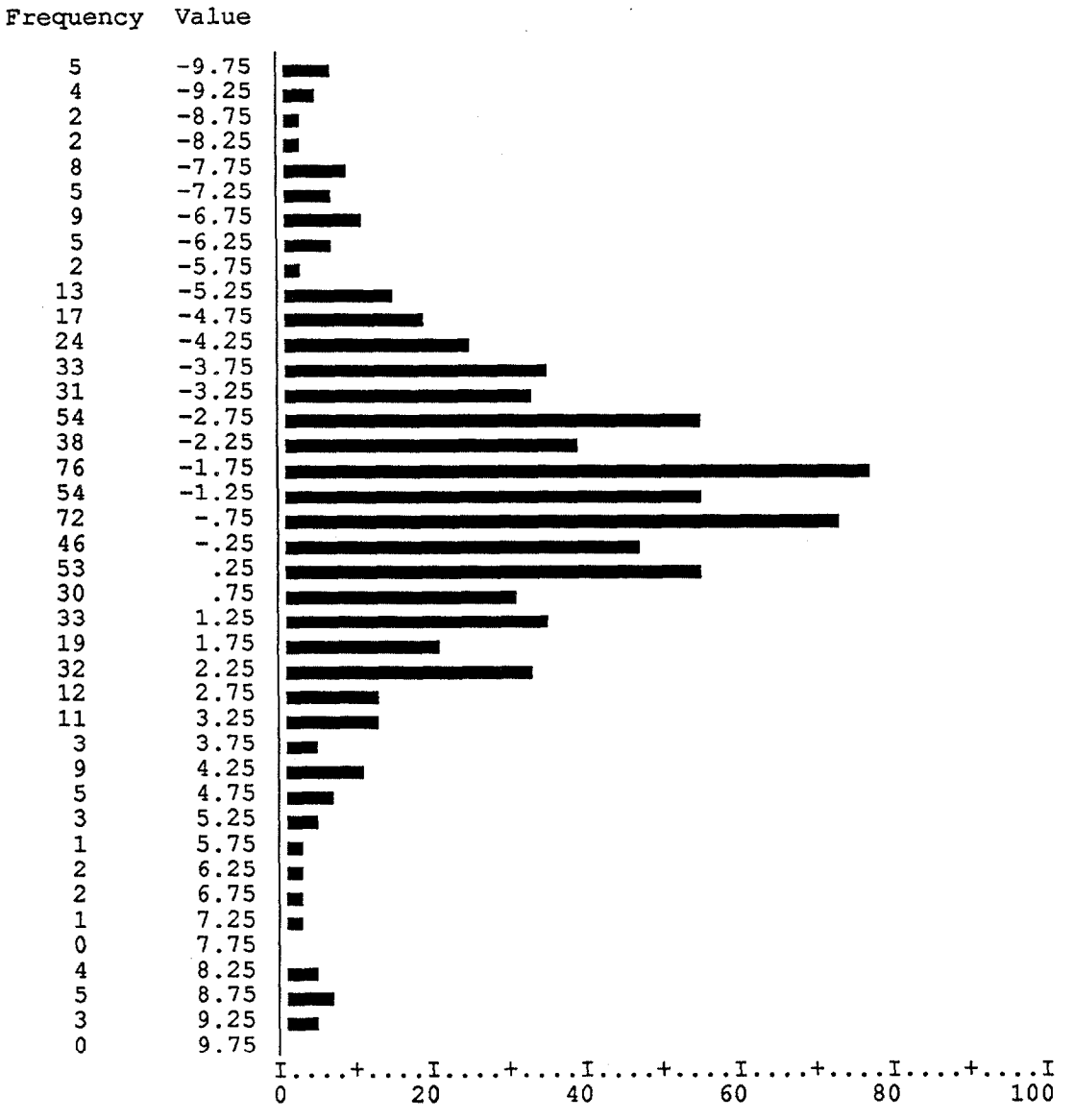
*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

HORIZONTAL AIM OF RIGHT LAMP (continued)*

Value	Frequency	Percent	Valid Percent	Cum Percent
6.50	1	.1	.1	98.1
6.75	1	.1	.1	98.2
7.00	1	.1	.1	98.4
8.00	4	.5	.5	98.9
8.50	5	.7	.7	99.6
9.00	3	.4	.4	100.0
TOTAL	728	100.0	100.0	

*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

HORIZONTAL AIM OF RIGHT LAMP (continued)*



*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

Mean	-1.362	Std Err	.112	Median	-1.500
Mode	-2.000	Std Dev	3.016	Variance	9.095
Kurtosis	1.561	S E Kurt	.181	Skewness	.255
S E Skew	.091	Range	19.000	Minimum	-10.000
Maximum	9.000	Sum	-991.250		

APPENDIX E

CORRELATIONS OF HEADLAMP AIM VARIABLES

TABLE OF ABBREVIATIONS FOR VARIABLES IN HEADLAMP AIM CORRELATIONAL ANALYSIS

INSPDATE = NUMBER OF MONTHS SINCE LAST INSPECTION OR BLANK IF MARYLAND VEHICLE
VEHICTYP = TYPE OF VEHICLE: 1=CAR, 2=VAN, 3=PICKUP, 4=UTILITY VEHICLE
VEHICYR = YEAR VEHICLE WAS BUILT
ODOMETER = ODOMETER READING AT TIME OF DATA COLLECTION
RPLITERT = 1=RIGHT LAMP/BULBS HAVE BEEN REPLACED BY SELF
2=RIGHT LAMP/BULBS HAVE NOT BEEN REPLACED
3=RIGHT LAMP/BULBS HAVE BEEN REPLACED BY STATE INSPECTOR
4=RIGHT LAMP/BULBS HAVE BEEN REPLACED BY REPAIR SHOP
5=RIGHT LAMP/BULBS HAVE BEEN REPLACED BY OTHER SOURCE
6=RIGHT LAMP/BULBS HAVE BEEN REPLACED BY UNKNOWN SOURCE
7=ONLY RIGHT BULBS HAVE BEEN REPLACED
8=UNCERTAIN ABOUT WHETHER RIGHT LAMP/BULBS HAVE BEEN REPLACED
RPLITELF = 1=LEFT LAMP/BULBS HAVE BEEN REPLACED BY SELF
2=LEFT LAMP/BULBS HAVE NOT BEEN REPLACED
3=LEFT LAMP/BULBS HAVE BEEN REPLACED BY STATE INSPECTOR
4=LEFT LAMP/BULBS HAVE BEEN REPLACED BY REPAIR SHOP
5=LEFT LAMP/BULBS HAVE BEEN REPLACED BY OTHER SOURCE
6=LEFT LAMP/BULBS HAVE BEEN REPLACED BY UNKNOWN SOURCE
7=ONLY LEFT BULBS HAVE BEEN REPLACED
8=UNCERTAIN ABOUT WHETHER LEFT LAMP/BULBS HAVE BEEN REPLACED
AIMLITRT = 1=RIGHT LAMP/BULBS HAVE BEEN AIMED BY SELF
2=RIGHT LAMP/BULBS HAVE NOT BEEN AIMED
3=RIGHT LAMP/BULBS HAVE BEEN AIMED BY STATE INSPECTOR
4=RIGHT LAMP/BULBS HAVE BEEN AIMED BY REPAIR SHOP
5=RIGHT LAMP/BULBS HAVE BEEN AIMED BY OTHER SOURCE
6=RIGHT LAMP/BULBS HAVE BEEN AIMED BY UNKNOWN SOURCE
7=ONLY RIGHT BULBS HAVE BEEN AIMED
8=UNCERTAIN ABOUT WHETHER RIGHT LAMP/BULBS HAVE BEEN AIMED
AIMLITLF = 1=LEFT LAMP/BULBS HAVE BEEN AIMED BY SELF
2=LEFT LAMP/BULBS HAVE NOT BEEN AIMED
3=LEFT LAMP/BULBS HAVE BEEN AIMED BY STATE INSPECTOR
4=LEFT LAMP/BULBS HAVE BEEN AIMED BY REPAIR SHOP
5=LEFT LAMP/BULBS HAVE BEEN AIMED BY OTHER SOURCE
6=LEFT LAMP/BULBS HAVE BEEN AIMED BY UNKNOWN SOURCE
7=ONLY LEFT BULBS HAVE BEEN AIMED
8=UNCERTAIN ABOUT WHETHER LEFT LAMP/BULBS HAVE BEEN AIMED
FUELSTAT = STATUS OF FUEL GAGE

TABLE OF ABBREVIATIONS FOR VARIABLES IN HEADLAMP AIM CORRELATIONAL ANALYSIS (continued)

LOAD = LOAD IN VEHICLE AT TIME OF DATA COLLECTION:
1=DRIVER ONLY
2=DRIVER AND ADULT PASSENGER
3=DRIVER AND LOAD LESS THAN 100 LB
4=DRIVER AND LOAD GREATER THAN 100 LB INCLUDING PASSENGERS

LAMPRETR = LAMPS 1=ARE OR 2=ARE NOT RETRACTABLE
LAMPMATL = LAMP LENSES ARE MADE OF 1=PLASTIC OR 2=GLASS
LAMPTYP = LAMPS ARE 1=SEALED BEAM, 2=REPLACEABLE BULB TYPE, OR 3=INTEGRAL
LAMPHITE = HEIGHT OF LAMPS FROM GROUND TO MIDDLE OF LAMPS IN INCHES
MOISTRT = RIGHT LAMP 1=HAS OR 2=DOES NOT HAVE MOISTURE INSIDE LENS
MOISTLF = LEFT LAMP 1=HAS OR 2=DOES NOT HAVE MOISTURE INSIDE LENS
DAMREFRT = RIGHT LAMP 1=HAS OR 2=DOES NOT HAVE REFLECTOR DAMAGE
DAMREFLF = LEFT LAMP 1=HAS OR 2=DOES NOT HAVE REFLECTOR DAMAGE
BROKLNRT = RIGHT LAMP LENS 1=IS OR 2=IS NOT BROKEN
BROKLNLF = LEFT LAMP LENS 1=IS OR 2=IS NOT BROKEN
UPDOWNRT = RIGHT LAMP 1=IS OR 2=IS NOT UPSIDE DOWN IN HOUSING
UPDOWNLF = LEFT LAMP 1=IS OR 2=IS NOT UPSIDE DOWN IN HOUSING
LOOSERT = RIGHT LAMP 1=IS OR 2=IS NOT LOOSE IN HOUSING
LOOSELF = LEFT LAMP 1=IS OR 2=IS NOT LOOSE IN HOUSING
DIRTLNRT = RIGHT LAMP LENS DIRT IS 1=LIGHT, 2=MEDIUM, OR 3=HEAVY
DIRTLNLF = LEFT LAMP LENS DIRT IS 1=LIGHT, 2=MEDIUM, OR 3=HEAVY
ADAPVERT = VERTICAL AIM ADAPTER READINGS
ADAPHORZ = HORIZONTAL AIM ADAPTER READINGS
LEFTVERT = VERTICAL AIM OF LEFT LAMP
LEFTHORZ = HORIZONTAL AIM OF LEFT LAMP
RITEVERT = VERTICAL AIM OF RIGHT LAMP
RITEHORZ = HORIZONTAL AIM OF RIGHT LAMP

CORRELATIONS OF HEADLAMP AIM VARIABLES

	INSPDATE	VEHICTYP	VEHICYR	ODOMETER	RPLITERT	RPLITELF	AIMLITRT	AIMLITLF	FUELSTAT	LOAD	LAMPRETR	LAMPMATL
INSPDATE	1.0000	-.0048	-.0988	.1648	.0355	.0421	.0960	.0924	.1057	.0066	-.0366	-.0146
VEHICTYP	-.0048	1.0000	.1221	-.0658	-.0517	-.0652	-.0628	-.0674	-.0778	.1118	.1249	-.0706
VEHICYR	-.0988	.1221	1.0000	-.8356**	-.2388**	-.2400**	-.2510**	-.2519**	-.0625	-.0778	-.0637	-.1425
ODOMETER	.1648	-.0658	-.8356**	1.0000	.2120*	.2128*	.2644**	.2631**	.0227	.0928	.0457	.1260
RPLITERT	.0355	-.0517	-.2388**	.2120*	1.0000	.9740**	.7855**	.7800**	.0391	.0162	.0970	-.0471
RPLITELF	.0421	-.0652	-.2400**	.2128*	.9740**	1.0000	.7823**	.7833**	.0455	.0253	.1000	-.0693
AIMLITRT	.0960	-.0628	-.2510**	.2644**	.7855**	.7823**	1.0000	.9939**	.1517	.0249	.0242	-.0656
AIMLITLF	.0924	-.0674	-.2519**	.2631**	.7800**	.7833**	.9939**	1.0000	.1492	.0287	.0273	-.0572
FUELSTAT	.1057	-.0778	-.0625	.0227	.0391	.0455	.1517	.1492	1.0000	.0616	.0233	-.1806
LOAD	.0066	.1118	-.0778	.0928	.0162	.0253	.0249	.0287	.0616	1.0000	.0853	-.1529
LAMPRETR	-.0366	.1249	-.0637	.0457	.0970	.1000	.0242	.0273	.0233	.0853	1.0000	-.0966
LAMPMATL	-.0146	-.0706	-.1425	.1260	-.0471	-.0693	-.0656	-.0572	-.1806	-.1529	-.0966	1.0000
LAMPTYP	-.1263	-.2599**	.2709**	-.2103*	.0144	-.0010	-.0004	.0027	-.0169	-.0431	.3453**	-.1610
LAMPHITE	.0313	.8548**	.1584	-.1036	-.0953	-.0937	-.1083	-.1138	-.0685	.1169	.0623	-.1646
MOISTRT	-.1339	.0778	.1152	-.1017	-.2740**	-.2743**	-.2763**	-.2746**	-.0142	-.0063	-.0333	.0669
MOISTLF	-.0117	.0778	.1549	-.1768	-.0377	-.0365	-.0522	-.0503	-.0142	-.0063	-.0333	.1463
BROKLNRT	-.0317	.0547	.0671	-.0200	-.1160	-.1157	-.1155	-.1143	-.0606	.0374	-.0234	-.0646
BROKLNLF	-.0942	.0547	-.0167	.0106	-.1160	-.1157	-.1155	-.1143	-.0606	.0374	-.0234	-.0646
LOOSERT	.0043	.0872	.0802	-.0321	-.0382	-.0696	-.0333	-.0648	-.0321	-.1004	-.0373	.0394
LOOSELF	-.0453	.0672	.0252	.0063	.0040	.0053	.0087	-.0327	.0084	.0459	-.0288	.0121
DIRTLNRT	.1164	-.1492	-.2645**	.3491**	.1272	.1551	.1792	.1897*	-.0575	.0130	-.1379	-.0372
DIRTLNLF	.1164	-.1492	-.2645**	.3491**	.1272	.1551	.1792	.1897*	-.0575	.0130	-.1379	-.0372
ADAPVERT	-.0984	-.3582**	.1858*	-.1256	.0300	.0195	.0063	.0052	.0678	-.0286	.2412**	-.2467**
ADAPHORZ	-.1657	-.3485**	.3336**	-.2779**	-.0695	-.0713	-.0285	-.0088	-.0161	-.0236	.2572**	-.1002
LEFTVERT	.0296	-.0540	-.0460	.0740	.0826	.0778	-.1018	-.0817	-.1533	-.0289	.0502	.0011
LEFTHORZ	-.0755	.0395	-.0832	.1285	.0035	.0369	-.0980	-.0346	-.1205	.0012	.0505	.1422
RITEVERT	-.0856	.0108	-.1171	.1135	.1444	.1083	.1364	.1337	-.1045	.0989	.0428	-.1327
RITEHORZ	-.0697	.0233	-.0800	.0504	.0835	.1070	.1095	.1062	.0446	-.0534	.0510	-.0467

2-tailed Significance: * - .01 ** - .001

Note: A significant negative correlation indicates that values of one variable tend to increase as values of the other variable tend to decrease. Conversely, a significant postitive correlation indicates that values of one variable tend to increase as values of the other variable also tend to increase. Correlations of particular interest are highlighted.

CORRELATIONS OF HEADLAMP AIM VARIABLES (continued)

	LAMPTYP	LAMPHITE	MOISTRT	MOISTLF	BROKLNRT	BROKLNLF	LOOSERT	LOOSELF	DIRTLNRT	DIRTLNLF	ADAPVERT	ADAPHORZ
INSPDATE	-.1263	.0313	-.1339	-.0117	-.0317	-.0942	.0043	-.0453	.1164	.1164	-.0984	-.1657
VEHICTYP	-.2599**	.8548**	.0778	.0778	.0547	.0547	.0872	.0672	-.1492	-.1492	-.3582**	-.3485**
VEHICYR	.2709**	.1584	.1152	.1549	.0671	-.0167	.0802	.0252	-.2645**	-.2645**	.1858*	.3336**
ODOMETER	-.2103*	-.1036	-.1017	-.1768	-.0200	.0106	-.0321	.0063	.3491**	.3491**	-.1256	-.2779**
RPLITERT	.0144	-.0953	-.2740**	-.0377	-.1160	-.1160	-.0382	.0040	.1272	.1272	.0300	-.0695
RPLITELF	-.0010	-.0937	-.2743**	-.0365	-.1157	-.1157	-.0696	.0053	.1551	.1551	.0195	-.0713
AIMLITRT	-.0004	-.1083	-.2763**	-.0522	-.1155	-.1155	-.0333	.0087	.1792	.1792	.0063	-.0285
AIMLITLF	.0027	-.1138	-.2746**	-.0503	-.1143	-.1143	-.0648	-.0327	.1897*	.1897*	.0052	-.0088
FUELSTAT	-.0169	-.0685	-.0142	-.0142	-.0606	-.0606	-.0321	.0084	-.0575	-.0575	.0678	-.0161
LOAD	-.0431	.1169	-.0063	-.0063	.0374	.0374	-.1004	.0459	.0130	.0130	-.0286	-.0236
LAMPRETR	.3453**	.0623	-.0333	-.0333	-.0234	-.0234	-.0373	-.0288	-.1379	-.1379	.2412**	.2572**
LAMPMATL	-.1610	-.1646	.0669	.1463	-.0646	-.0646	.0394	.0121	-.0372	-.0372	-.2467**	-.1002
LAMPTYP	1.0000	-.2674**	.0593	.1371	-.0678	-.0678	-.1081	-.0833	-.1093	-.1093	.6985**	.7449**
LAMPHITE	-.2674**	1.0000	.0348	.0448	.0386	.0174	.0976	.0648	-.0510	-.0510	-.3788**	-.3846**
MOISTRT	.0593	.0348	1.0000	.4896**	-.0146	-.0146	-.0232	-.0179	-.1692	-.1692	.0162	.0614
MOISTLF	.1371	.0448	.4896**	1.0000	-.0146	-.0146	-.0232	-.0179	-.0998	-.0998	.0508	.1169
BROKLNRT	-.0678	.0386	-.0146	-.0146	1.0000	.4949**	-.0163	-.0126	-.1190	-.1190	.0205	-.0349
BROKLNLF	-.0678	.0174	-.0146	-.0146	.4949**	1.0000	-.0163	-.0126	-.0213	-.0213	-.0159	-.0263
LOOSERT	-.1081	.0976	-.0232	-.0232	-.0163	-.0163	1.0000	-.0201	-.0028	-.0028	-.1299	-.0972
LOOSELF	-.0833	.0648	-.0179	-.0179	-.0126	-.0126	-.0201	1.0000	-.0662	-.0662	-.0842	-.0891
DIRTLNRT	-.1093	-.0510	-.1692	-.0998	-.1190	-.0213	-.0028	-.0662	1.0000	1.0000**	-.2059*	-.1268
DIRTLNLF	-.1093	-.0510	-.1692	-.0998	-.1190	-.0213	-.0028	-.0662	1.0000**	1.0000	-.2059*	-.1268
ADAPVERT	.6985**	-.3788**	.0162	.0508	.0205	-.0159	-.1299	-.0842	-.2059*	-.2059*	1.0000	.7172**
ADAPHORZ	.7449**	-.3846**	.0614	.1169	-.0349	-.0263	-.0972	-.0891	-.1268	-.1268	.7172**	1.0000
LEFTVERT	.0668	-.1122	.0322	.0444	.0295	.0295	-.2566**	-.3471**	-.0778	-.0778	.1480	.0569
LEFTHORZ	-.0861	.0088	.0318	.0327	.0299	.0324	-.1326	-.1690	-.0107	-.0107	-.1309	-.0070
RITEVERT	-.0369	-.0052	-.1304	-.1226	.0277	.0376	-.2435**	-.1462	-.0070	-.0070	.0308	-.0623
RITEHORZ	.0379	.0621	.0232	.0267	.0152	.0176	-.2538**	-.0285	-.0051	-.0051	.1249	.0194

2-tailed Significance: * - .01 ** - .001

Note: A significant negative correlation indicates that values of one variable tend to increase as values of the other variable tend to decrease. Conversely, a significant postitive correlation indicates that values of one variable tend to increase as values of the other variable also tend to increase. Correlations of particular interest are highlighted.

CORRELATIONS OF HEADLAMP AIM VARIABLES (continued)

	LEFTVERT	LEFTHORZ	RITEVERT	RITEHORZ
INSPDATE	.0296	-.0755	-.0856	-.0697
VEHICTYP	-.0540	.0395	.0108	.0233
VEHICYR	-.0460	-.0832	-.1171	-.0800
ODOMETER	.0740	.1285	.1135	.0504
RPLITERT	.0826	.0035	.1444	.0835
RPLITELF	.0778	.0369	.1083	.1070
AIMLITRT	-.1018	-.0980	.1364	.1095
AIMLITLF	-.0817	-.0346	.1337	.1062
FUELSTAT	-.1533	-.1205	-.1045	.0446
LOAD	-.0289	.0012	.0989	-.0534
LAMPRETR	.0502	.0505	.0428	.0510
LAMPMATL	.0011	.1422	-.1327	-.0467
LAMPTYP	.0668	-.0861	-.0369	.0379
LAMPHITE	-.1122	.0088	-.0052	.0621
MOISTRT	.0322	.0318	-.1304	.0232
MOISTLF	.0444	.0327	-.1226	.0267
BROKLNRT	.0295	.0299	.0277	.0152
BROKLNLF	.0295	.0324	.0376	.0176
LOOSERT	-.2566**	-.1326	-.2435**	-.2538**
LOOSELF	-.3471**	-.1690	-.1462	-.0285
DIRTLNRT	-.0778	-.0107	-.0070	-.0051
DIRTLNLF	-.0778	-.0107	-.0070	-.0051
ADAPVERT	.1480	-.1309	.0308	.1249
ADAPHORZ	.0569	-.0070	-.0623	.0194
LEFTVERT	1.0000	.1807	.2618**	-.0120
LEFTHORZ	.1807	1.0000	.1879*	-.0364
RITEVERT	.2618**	.1879*	1.0000	.1680
RITEHORZ	-.0120	-.0364	.1680	1.0000

2-tailed Significance: * - .01 ** - .001

Note: A significant negative correlation indicates that values of one variable tend to increase as values of the other variable tend to decrease. Conversely, a significant postitive correlation indicates that values of one variable tend to increase as values of the other variable also tend to increase. Correlations of particular interest are highlighted.

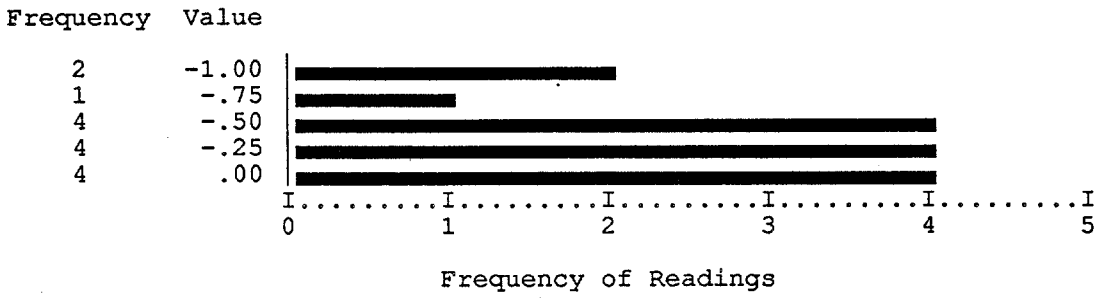
APPENDIX F

HEADLIGHT ALIGNMENT AS AFFECTED BY FUEL LEVEL: FREQUENCY TABLE, HISTOGRAM, AND SUMMARY STATISTICS

HEADLIGHT ALIGNMENT AS AFFECTED BY FUEL LEVEL: FREQUENCY TABLE, HISTOGRAM, AND SUMMARY STATISTICS

VERTICAL HEADLAMP AIM DIFFERENCE AFTER FUELING*

Value	Frequency	Percent	Valid Percent	Cum Percent
-1.00	2	.3	13.3	13.3
-.75	1	.1	6.7	20.0
-.50	4	.5	26.7	46.7
-.25	4	.5	26.7	73.3
.00	4	.5	26.7	100.0
.	753	98.0	MISSING	
TOTAL	768	100.0	100.0	



*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

Mean	-.383	Std Err	.088	Median	-.250
Mode	-.500	Std Dev	.339	Variance	.115
Kurtosis	-.475	S E Kurt	1.121	Skewness	-.614
S E Skew	.580	Range	1.000	Minimum	-1.000
Maximum	.000	Sum	-5.750		

APPENDIX G

HEADLAMP AIM AS MEASURED BY FRACTIONAL BALANCE AIMER: FREQUENCY TABLES, HISTOGRAMS, AND SUMMARY STATISTICS

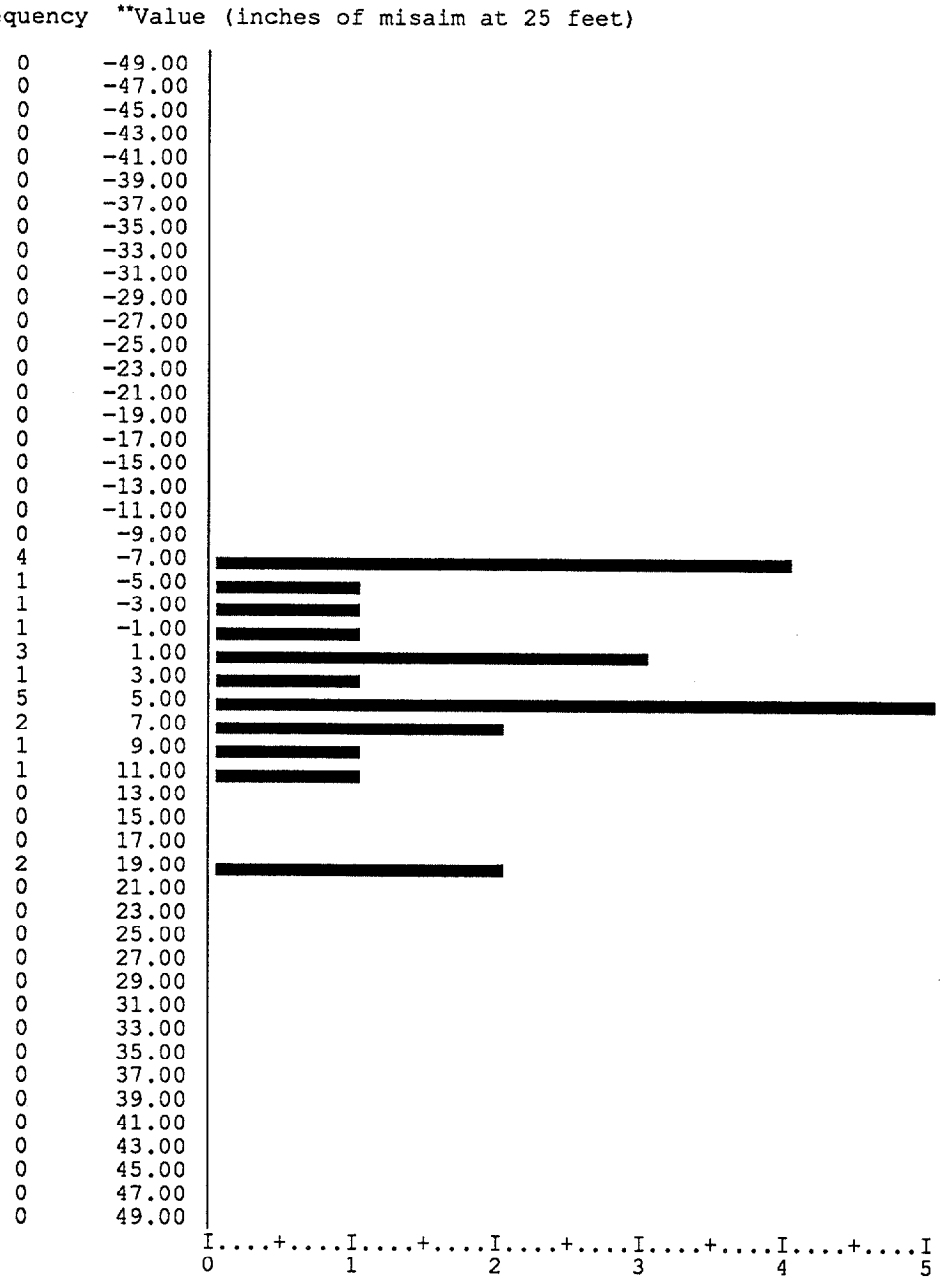
HEADLAMP AIM AS MEASURED BY FRACTIONAL BALANCE AIMER: FREQUENCY TABLES, HISTOGRAMS, AND SUMMARY STATISTICS

VERTICAL AIM OF LEFT LAMP USING FRACTIONAL BALANCE AIMER*

Value	Frequency	Percent	Valid Percent	Cum Percent
-8.00	1	.1	4.5	4.5
-7.80	1	.1	4.5	9.1
-6.80	2	.3	9.1	18.2
-4.80	1	.1	4.5	22.7
-2.80	1	.1	4.5	27.3
-1.80	1	.1	4.5	31.8
.20	2	.3	9.1	40.9
.70	1	.1	4.5	45.5
2.20	1	.1	4.5	50.0
4.00	1	.1	4.5	54.5
4.20	2	.3	9.1	63.6
4.70	1	.1	4.5	68.2
5.80	1	.1	4.5	72.7
6.00	2	.3	9.1	81.8
9.00	1	.1	4.5	86.4
10.00	1	.1	4.5	90.9
18.20	2	.3	9.1	100.0
TOTAL	22	100.0	100.0	

*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

VERTICAL AIM OF LEFT LAMP USING FRACTIONAL BALANCE AIMER (continued)*



*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim
**Aim values are presented at intervals of 1.0 inches

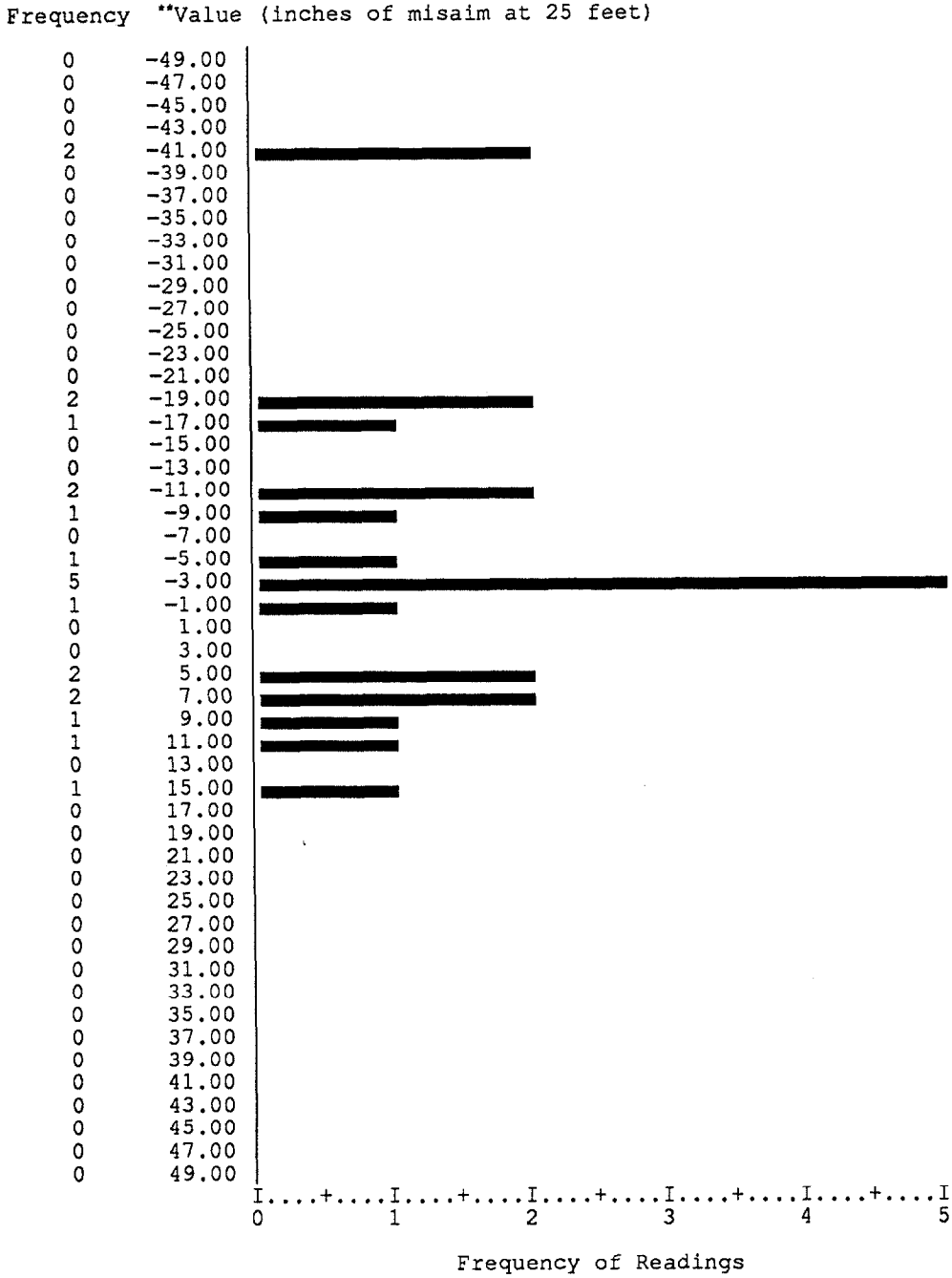
Mean	2.491	Std Err	1.573	Median	3.100
Mode	-6.800	Std Dev	7.377	Variance	54.421
Range	26.200	Minimum	-8.000	Maximum	18.200

HORIZONTAL AIM OF LEFT LAMP USING FRACTIONAL BALANCE AIMER*

Value	Frequency	Percent	Valid Percent	Cum Percent
-41.30	1	.1	4.5	4.5
-40.40	1	.1	4.5	9.1
-19.40	1	.1	4.5	13.6
-19.00	1	.1	4.5	18.2
-17.60	1	.1	4.5	22.7
-12.00	1	.1	4.5	27.3
-11.00	1	.1	4.5	31.8
-9.00	1	.1	4.5	36.4
-5.80	1	.1	4.5	40.9
-4.00	4	.5	18.2	59.1
-3.50	1	.1	4.5	63.6
-2.00	1	.1	4.5	68.2
4.00	1	.1	4.5	72.7
5.60	1	.1	4.5	77.3
6.40	2	.3	9.1	86.4
9.70	1	.1	4.5	90.9
10.70	1	.1	4.5	95.5
14.10	1	.1	4.5	100.0
TOTAL	22	100.0	100.0	

*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

HORIZONTAL AIM OF LEFT LAMP USING FRACTIONAL AIMER (continued)*



*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

**Aim values are presented at intervals of 1.0 inches

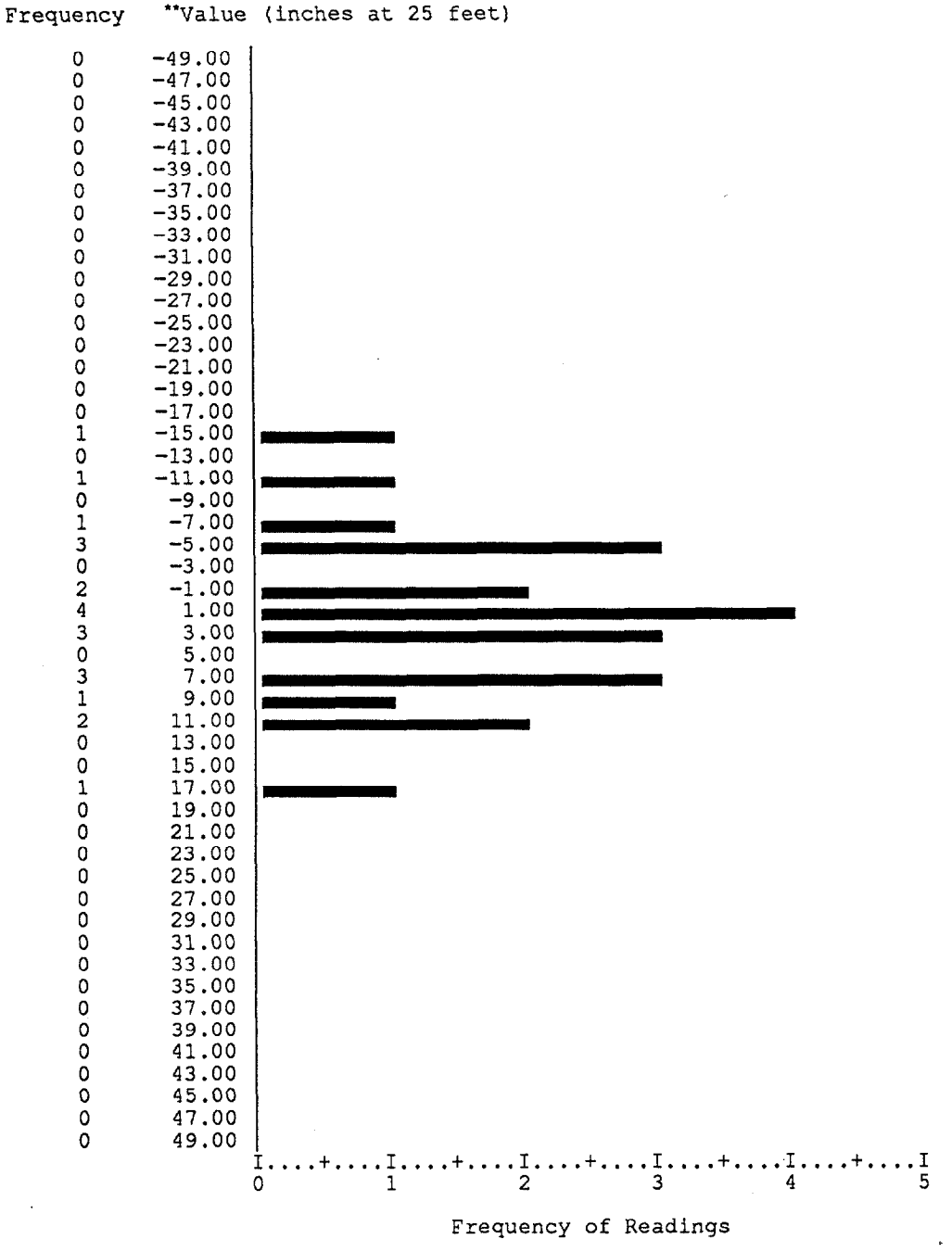
Mean	-6.368	Std Err	3.117	Median	-4.000
Mode	-4.000	Std Dev	14.621	Variance	213.778
Range	55.400	Minimum	-41.300	Maximum	14.100

VERTICAL AIM OF RIGHT LAMP USING FRACTIONAL BALANCE AIMER*

Value	Frequency	Percent	Valid Percent	Cum Percent
-14.80	1	.1	4.5	4.5
-10.70	1	.1	4.5	9.1
-6.40	1	.1	4.5	13.6
-6.00	1	.1	4.5	18.2
-5.40	1	.1	4.5	22.7
-5.00	1	.1	4.5	27.3
-.80	2	.3	9.1	36.4
1.20	3	.4	13.6	50.0
1.70	1	.1	4.5	54.5
2.20	3	.4	13.6	68.2
6.70	1	.1	4.5	72.7
7.00	2	.3	9.1	81.8
8.00	1	.1	4.5	86.4
10.00	1	.1	4.5	90.9
11.00	1	.1	4.5	95.5
16.20	1	.1	4.5	100.0
TOTAL	22	100.0	100.0	

*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim

VERTICAL AIM OF RIGHT LAMP USING FRACTIONAL BALANCE AIMER (continued)*



*A negative sign indicates upward vertical aim; no sign indicates downward vertical aim
**Aim values are presented at intervals of 1.0 inches

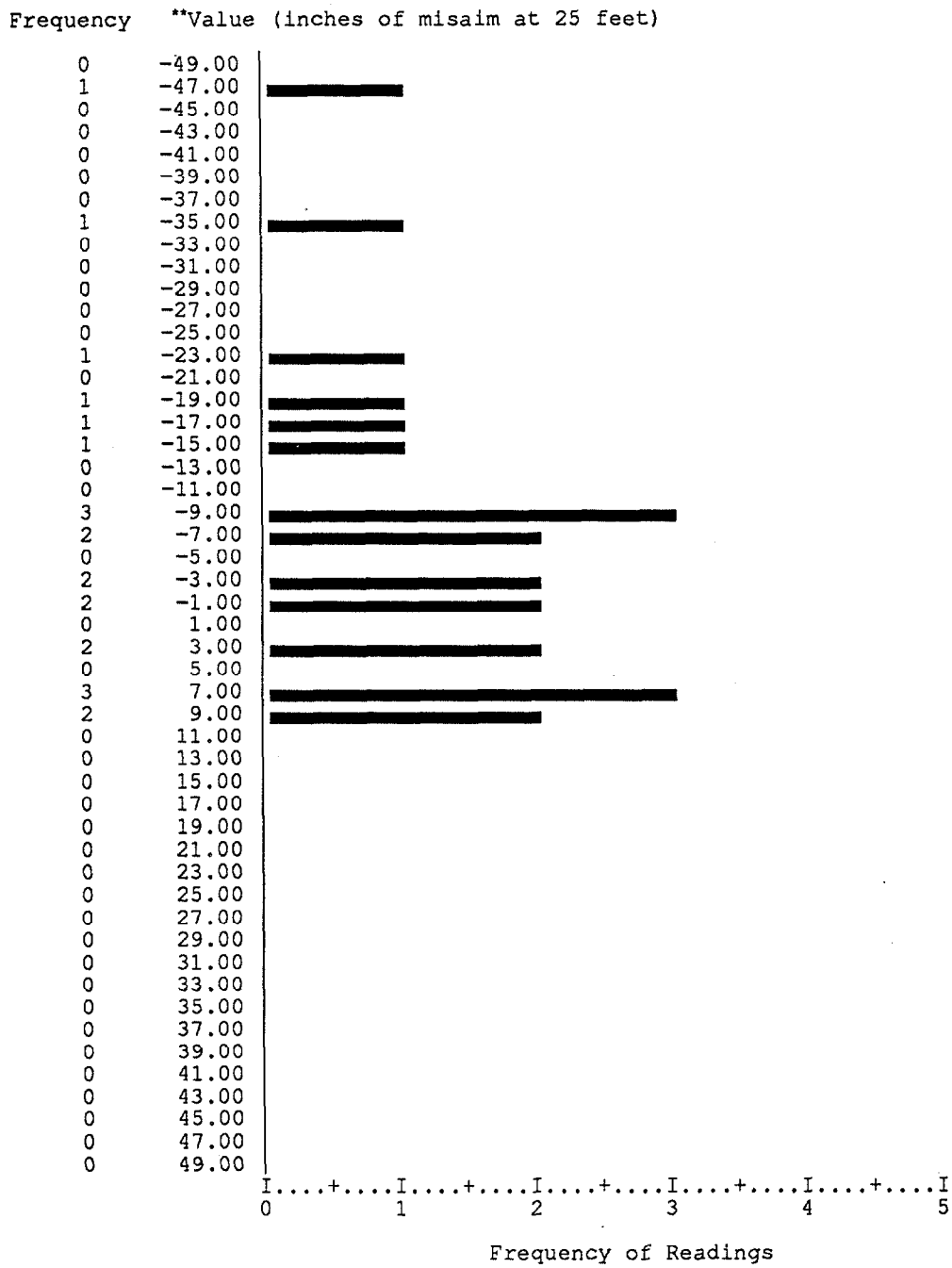
Mean	1.268	Std Err	1.573	Median	1.450
Mode	1.200	Std Dev	7.376	Variance	54.410
Range	31.000	Minimum	-14.800	Maximum	16.200

HORIZONTAL AIM OF RIGHT LAMP USING FRACTIONAL BALANCE AIMER*

Value	Frequency	Percent	Valid Percent	Cum Percent
-46.30	1	.1	4.5	4.5
-35.40	1	.1	4.5	9.1
-24.00	1	.1	4.5	13.6
-19.60	1	.1	4.5	18.2
-16.50	1	.1	4.5	22.7
-16.00	1	.1	4.5	27.3
-10.00	2	.3	9.1	36.4
-8.80	1	.1	4.5	40.9
-8.00	1	.1	4.5	45.5
-7.20	1	.1	4.5	50.0
-4.00	1	.1	4.5	54.5
-3.20	1	.1	4.5	59.1
-2.00	1	.1	4.5	63.6
-1.00	1	.1	4.5	68.2
2.20	1	.1	4.5	72.7
2.80	1	.1	4.5	77.3
6.80	1	.1	4.5	81.8
7.10	1	.1	4.5	86.4
7.90	1	.1	4.5	90.9
9.10	1	.1	4.5	95.5
9.70	1	.1	4.5	100.0
TOTAL	22	100.0	100.0	

*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

HORIZONTAL AIM OF RIGHT LAMP USING FRACTIONAL AIMER (continued)*



*A negative sign indicates leftward horizontal aim; no sign indicates rightward horizontal aim

**Aim values are presented at intervals of 1.0 inches

Mean	-7.564	Std Err	3.086	Median	-5.600
Mode	-10.000	Std Dev	14.475	Variance	209.516
Range	56.000	Minimum	-46.300	Maximum	9.700

APPENDIX H

REAR LIGHTING SYSTEM MEASUREMENT FREQUENCY TABLES, HISTOGRAMS, AND SUMMARY STATISTICS

REAR LIGHTING SYSTEM MEASUREMENT
FREQUENCY TABLES, HISTOGRAMS, AND SUMMARY STATISTICS

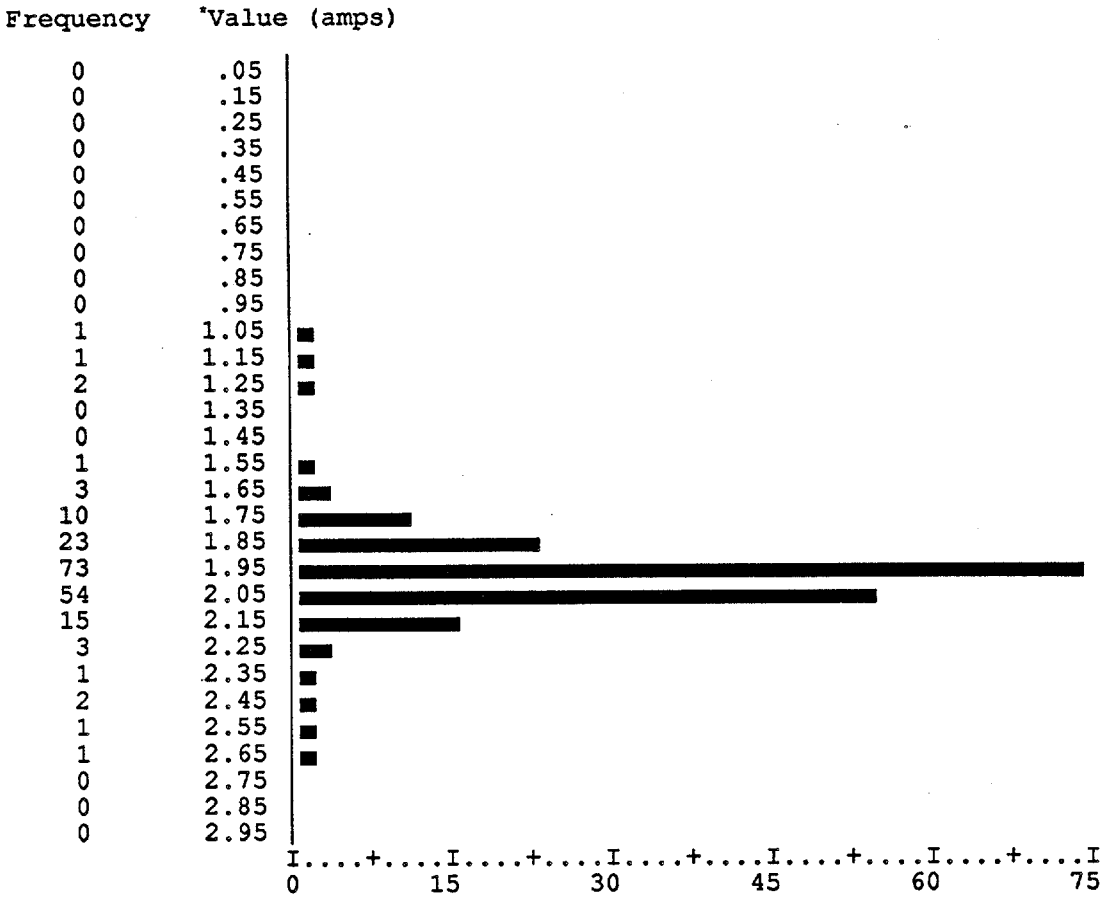
AMPERAGE READINGS AT LEFT STOP LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.06	1	.5	.5	.5
1.11	1	.5	.5	1.0
1.25	2	1.0	1.0	2.1
1.51	1	.5	.5	2.6
1.65	1	.5	.5	3.1
1.67	1	.5	.5	3.6
1.68	1	.5	.5	4.2
1.74	1	.5	.5	4.7
1.75	1	.5	.5	5.2
1.76	1	.5	.5	5.7
1.77	1	.5	.5	6.3
1.79	1	.5	.5	6.8
1.80	5	2.6	2.6	9.4
1.82	3	1.6	1.6	10.9
1.83	1	.5	.5	11.5
1.84	1	.5	.5	12.0
1.85	2	1.0	1.0	13.0
1.87	4	2.1	2.1	15.6
1.88	3	1.6	1.6	17.2
1.89	5	2.6	2.6	19.8
1.90	3	1.6	1.6	21.4
1.91	5	2.6	2.6	24.0
1.92	12	6.3	6.3	30.2
1.93	4	2.1	2.1	32.3
1.94	8	4.2	4.2	36.5
1.95	8	4.2	4.2	40.6
1.96	9	4.7	4.7	45.3
1.97	5	2.6	2.6	47.9
1.98	5	2.6	2.6	50.5
1.99	12	6.3	6.3	56.8
2.00	5	2.6	2.6	59.4
2.01	4	2.1	2.1	61.5
2.02	3	1.6	1.6	63.0
2.03	3	1.6	1.6	64.6
2.04	8	4.2	4.2	68.8
2.05	5	2.6	2.6	71.4
2.06	3	1.6	1.6	72.9
2.07	6	3.1	3.1	76.0
2.08	9	4.7	4.7	80.7
2.09	10	5.2	5.2	85.9
2.10	3	1.6	1.6	87.5

AMPERAGE READINGS AT LEFT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
2.11	5	2.6	2.6	90.1
2.12	2	1.0	1.0	91.1
2.13	1	.5	.5	91.7
2.15	5	2.6	2.6	94.3
2.16	1	.5	.5	94.8
2.17	2	1.0	1.0	95.8
2.21	1	.5	.5	96.4
2.22	1	.5	.5	96.9
2.23	1	.5	.5	97.4
2.40	1	.5	.5	97.9
2.42	1	.5	.5	98.4
2.49	1	.5	.5	99.0
2.57	1	.5	.5	99.5
2.62	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT LEFT STOP LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .10 amps

Mean	1.975	Std Err	.013	Median	1.980
Mode	1.920	Std Dev	.182	Variance	.033
Range	1.560	Minimum	1.060	Maximum	2.620

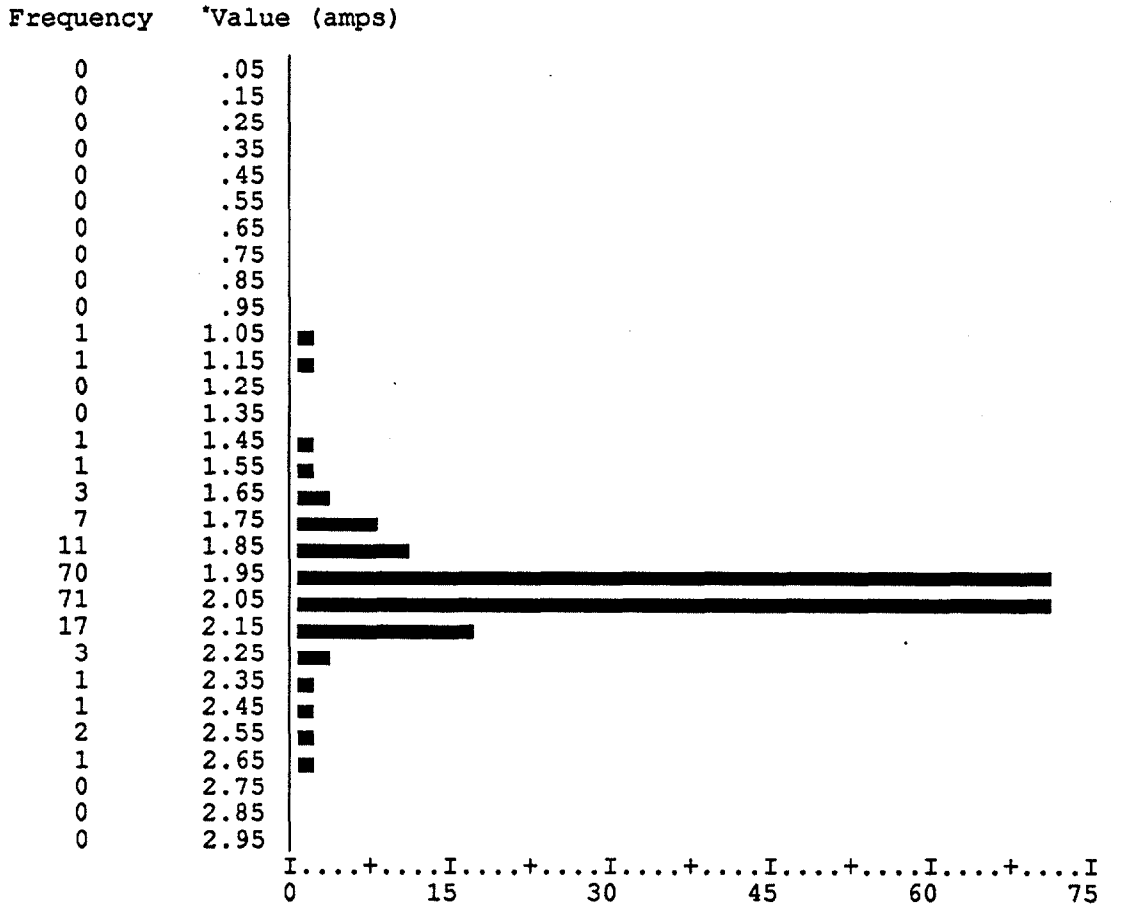
AMPERAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.06	1	.5	.5	.5
1.13	1	.5	.5	1.0
1.45	1	.5	.5	1.6
1.53	1	.5	.5	2.1
1.64	1	.5	.5	2.6
1.67	1	.5	.5	3.1
1.68	1	.5	.5	3.6
1.73	1	.5	.5	4.2
1.75	1	.5	.5	4.7
1.76	1	.5	.5	5.2
1.79	1	.5	.5	5.7
1.80	3	1.6	1.6	7.3
1.84	2	1.0	1.0	8.3
1.85	1	.5	.5	8.9
1.88	2	1.0	1.0	9.9
1.89	2	1.0	1.0	10.9
1.90	4	2.1	2.1	13.0
1.91	2	1.0	1.0	14.1
1.92	8	4.2	4.2	18.2
1.93	5	2.6	2.6	20.8
1.94	8	4.2	4.2	25.0
1.95	5	2.6	2.6	27.6
1.96	9	4.7	4.7	32.3
1.97	10	5.2	5.2	37.5
1.98	10	5.2	5.2	42.7
1.99	8	4.2	4.2	46.9
2.00	5	2.6	2.6	49.5
2.01	4	2.1	2.1	51.6
2.02	10	5.2	5.2	56.8
2.03	4	2.1	2.1	58.9
2.04	7	3.6	3.6	62.5
2.05	7	3.6	3.6	66.1
2.06	4	2.1	2.1	68.2
2.07	9	4.7	4.7	72.9
2.08	9	4.7	4.7	77.6
2.09	7	3.6	3.6	81.3
2.10	10	5.2	5.2	86.5
2.11	5	2.6	2.6	89.1
2.12	4	2.1	2.1	91.1
2.13	1	.5	.5	91.7
2.14	2	1.0	1.0	92.7
2.15	3	1.6	1.6	94.3
2.16	1	.5	.5	94.8
2.17	2	1.0	1.0	95.8
2.23	1	.5	.5	96.4

AMPERAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
2.26	1	.5	.5	96.9
2.30	1	.5	.5	97.4
2.39	1	.5	.5	97.9
2.49	1	.5	.5	98.4
2.55	1	.5	.5	99.0
2.57	1	.5	.5	99.5
2.62	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .10 amps

Mean	2.002	Std Err	.012	Median	2.010
Mode	1.970	Std Dev	.169	Variance	.029
Range	1.560	Minimum	1.060	Maximum	2.620

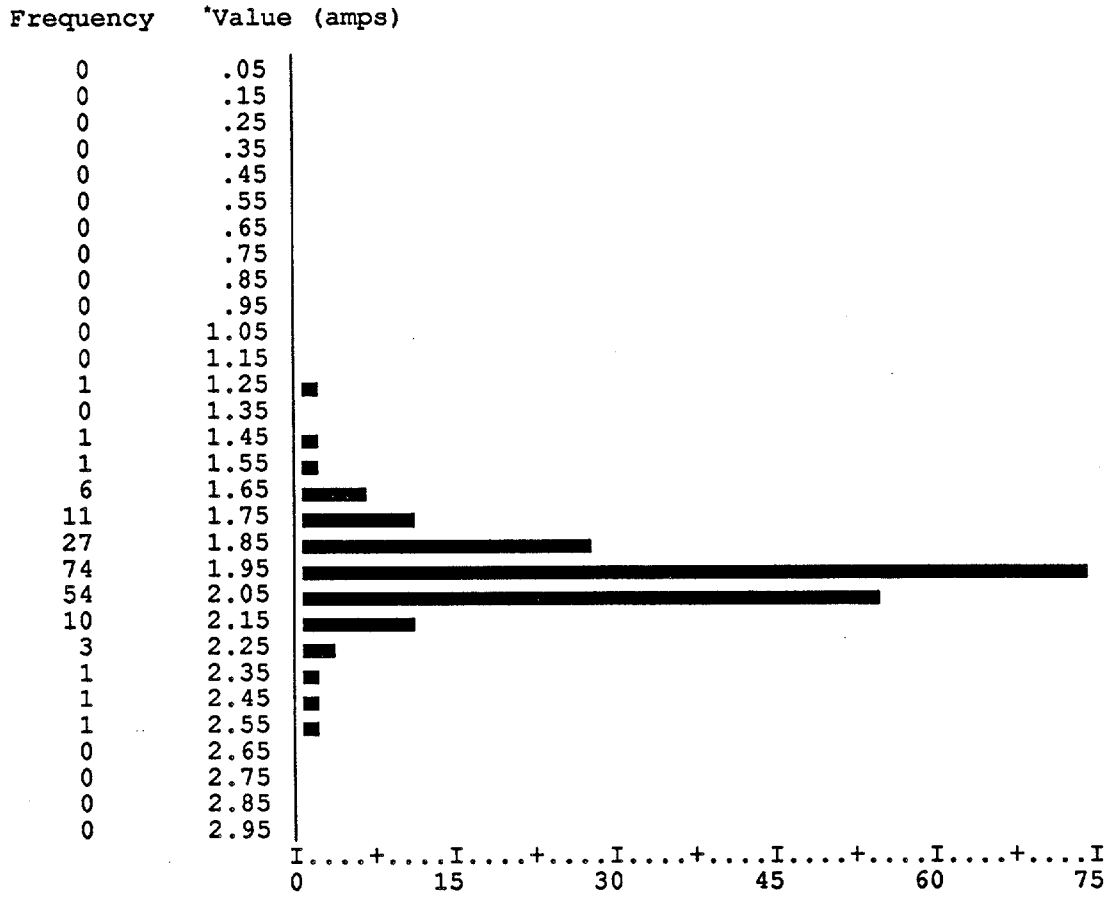
AMPERAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.30	1	.5	.5	.5
1.48	1	.5	.5	1.0
1.59	1	.5	.5	1.6
1.60	1	.5	.5	2.1
1.61	1	.5	.5	2.6
1.63	1	.5	.5	3.1
1.66	2	1.0	1.0	4.2
1.69	1	.5	.5	4.7
1.73	1	.5	.5	5.2
1.74	1	.5	.5	5.7
1.78	3	1.6	1.6	7.3
1.79	4	2.1	2.1	9.4
1.80	2	1.0	1.0	10.4
1.81	3	1.6	1.6	12.0
1.84	1	.5	.5	12.5
1.85	6	3.1	3.1	15.6
1.86	2	1.0	1.0	16.7
1.87	4	2.1	2.1	18.8
1.88	4	2.1	2.1	20.8
1.89	3	1.6	1.6	22.4
1.90	4	2.1	2.1	24.5
1.91	7	3.6	3.6	28.1
1.92	6	3.1	3.1	31.3
1.93	1	.5	.5	31.8
1.94	4	2.1	2.1	33.9
1.95	5	2.6	2.6	36.5
1.96	8	4.2	4.2	40.6
1.97	4	2.1	2.1	42.7
1.98	13	6.8	6.8	49.5
1.99	18	9.4	9.4	58.9
2.00	9	4.7	4.7	63.5
2.01	6	3.1	3.1	66.7
2.02	8	4.2	4.2	70.8
2.03	7	3.6	3.6	74.5
2.04	3	1.6	1.6	76.0
2.05	2	1.0	1.0	77.1
2.06	2	1.0	1.0	78.1
2.07	7	3.6	3.6	81.8
2.08	6	3.1	3.1	84.9
2.09	7	3.6	3.6	88.5
2.10	6	3.1	3.1	91.7
2.11	1	.5	.5	92.2
2.12	3	1.6	1.6	93.8
2.13	1	.5	.5	94.3
2.14	2	1.0	1.0	95.3

AMPERAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
2.16	2	1.0	1.0	96.4
2.17	1	.5	.5	96.9
2.20	1	.5	.5	97.4
2.27	1	.5	.5	97.9
2.30	1	.5	.5	98.4
2.32	1	.5	.5	99.0
2.50	1	.5	.5	99.5
2.55	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .10 amps

Mean	1.969	Std Err	.010	Median	1.990
Mode	1.990	Std Dev	.145	Variance	.021
Range	1.250	Minimum	1.300	Maximum	2.550

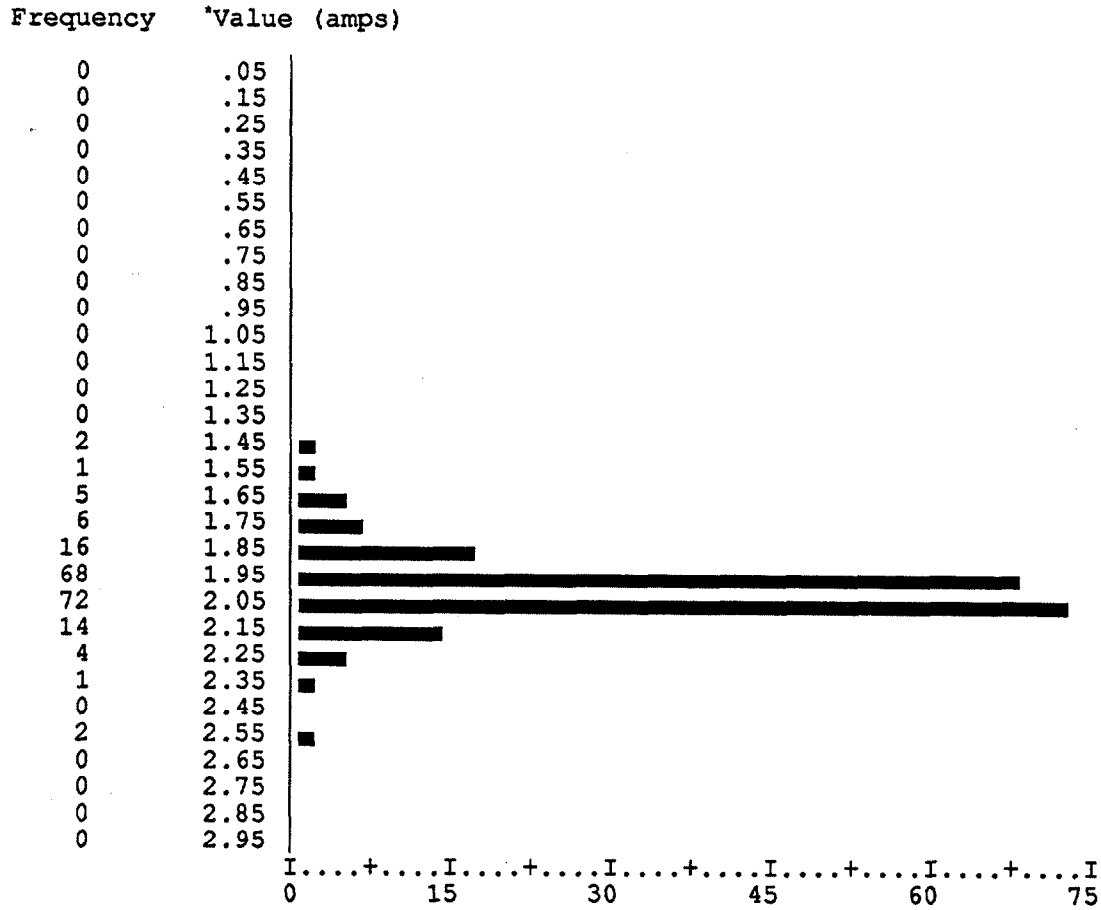
AMPERAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.45	1	.5	.5	.5
1.48	1	.5	.5	1.0
1.59	1	.5	.5	1.6
1.60	1	.5	.5	2.1
1.65	1	.5	.5	2.6
1.66	1	.5	.5	3.1
1.69	1	.5	.5	3.6
1.70	1	.5	.5	4.2
1.77	2	1.0	1.0	5.2
1.78	2	1.0	1.0	6.3
1.80	2	1.0	1.0	7.3
1.81	1	.5	.5	7.8
1.82	2	1.0	1.0	8.9
1.83	1	.5	.5	9.4
1.84	1	.5	.5	9.9
1.85	2	1.0	1.0	10.9
1.86	1	.5	.5	11.5
1.87	3	1.6	1.6	13.0
1.88	1	.5	.5	13.5
1.89	2	1.0	1.0	14.6
1.90	2	1.0	1.0	15.6
1.91	6	3.1	3.1	18.8
1.92	5	2.6	2.6	21.4
1.93	1	.5	.5	21.9
1.94	2	1.0	1.0	22.9
1.95	2	1.0	1.0	24.0
1.96	7	3.6	3.6	27.6
1.97	7	3.6	3.6	31.3
1.98	12	6.3	6.3	37.5
1.99	20	10.4	10.4	47.9
2.00	7	3.6	3.6	51.6
2.01	13	6.8	6.8	58.3
2.02	7	3.6	3.6	62.0
2.03	8	4.2	4.2	66.1
2.04	5	2.6	2.6	68.8
2.05	8	4.2	4.2	72.9
2.06	7	3.6	3.6	76.6
2.07	5	2.6	2.6	79.2
2.08	5	2.6	2.6	81.8
2.09	8	4.2	4.2	85.9
2.10	6	3.1	3.1	89.1
2.11	2	1.0	1.0	90.1
2.12	3	1.6	1.6	91.7
2.13	2	1.0	1.0	92.7
2.14	3	1.6	1.6	94.3

AMPERAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
2.16	2	1.0	1.0	95.3
2.17	2	1.0	1.0	96.4
2.20	1	.5	.5	96.9
2.27	2	1.0	1.0	97.9
2.30	1	.5	.5	98.4
2.32	1	.5	.5	99.0
2.55	2	1.0	1.0	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .10 amps

Mean	1.995	Std Err	.010	Median	2.000
Mode	1.990	Std Dev	.137	Variance	.019
Range	1.100	Minimum	1.450	Maximum	2.550

VOLTAGE READINGS AT LEFT STOP LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
8.47	1	.5	.5	.5
8.70	1	.5	.5	1.0
8.80	1	.5	.5	1.6
9.00	1	.5	.5	2.1
9.46	1	.5	.5	2.6
9.85	1	.5	.5	3.1
9.98	1	.5	.5	3.6
10.04	1	.5	.5	4.2
10.05	1	.5	.5	4.7
10.10	1	.5	.5	5.2
10.13	1	.5	.5	5.7
10.16	1	.5	.5	6.3
10.18	1	.5	.5	6.8
10.22	1	.5	.5	7.3
10.28	1	.5	.5	7.8
10.29	1	.5	.5	8.3
10.32	1	.5	.5	8.9
10.42	1	.5	.5	9.4
10.45	1	.5	.5	9.9
10.52	1	.5	.5	10.4
10.54	3	1.6	1.6	12.0
10.56	1	.5	.5	12.5
10.59	1	.5	.5	13.0
10.61	3	1.6	1.6	14.6
10.64	1	.5	.5	15.1
10.65	1	.5	.5	15.6
10.70	1	.5	.5	16.1
10.71	1	.5	.5	16.7
10.73	1	.5	.5	17.2
10.74	1	.5	.5	17.7
10.75	1	.5	.5	18.2
10.79	1	.5	.5	18.8
10.82	2	1.0	1.0	19.8
10.84	1	.5	.5	20.3
10.85	1	.5	.5	20.8
10.87	1	.5	.5	21.4
10.89	1	.5	.5	21.9
10.94	1	.5	.5	22.4
10.97	1	.5	.5	22.9
11.00	1	.5	.5	23.4
11.01	1	.5	.5	24.0
11.05	1	.5	.5	24.5
11.07	1	.5	.5	25.0
11.10	2	1.0	1.0	26.0
11.14	2	1.0	1.0	27.1
11.17	1	.5	.5	27.6

VOLTAGE READINGS AT LEFT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
11.18	1	.5	.5	28.1
11.20	1	.5	.5	28.6
11.25	2	1.0	1.0	29.7
11.33	1	.5	.5	30.2
11.35	1	.5	.5	30.7
11.37	1	.5	.5	31.3
11.40	1	.5	.5	31.8
11.43	1	.5	.5	32.3
11.44	1	.5	.5	32.8
11.47	1	.5	.5	33.3
11.49	1	.5	.5	33.9
11.50	1	.5	.5	34.4
11.51	2	1.0	1.0	35.4
11.54	3	1.6	1.6	37.0
11.61	1	.5	.5	37.5
11.65	1	.5	.5	38.0
11.66	1	.5	.5	38.5
11.68	1	.5	.5	39.1
11.69	1	.5	.5	39.6
11.70	2	1.0	1.0	40.6
11.72	1	.5	.5	41.1
11.73	1	.5	.5	41.7
11.75	1	.5	.5	42.2
11.76	1	.5	.5	42.7
11.77	2	1.0	1.0	43.8
11.79	1	.5	.5	44.3
11.80	4	2.1	2.1	46.4
11.82	2	1.0	1.0	47.4
11.83	1	.5	.5	47.9
11.84	1	.5	.5	48.4
11.85	1	.5	.5	49.0
11.89	1	.5	.5	49.5
11.90	1	.5	.5	50.0
11.92	1	.5	.5	50.5
11.93	2	1.0	1.0	51.6
11.94	3	1.6	1.6	53.1
11.96	2	1.0	1.0	54.2
11.97	1	.5	.5	54.7
11.99	2	1.0	1.0	55.7
12.02	1	.5	.5	56.3
12.03	1	.5	.5	56.8
12.04	1	.5	.5	57.3
12.05	1	.5	.5	57.8
12.10	2	1.0	1.0	58.9
12.16	1	.5	.5	59.4

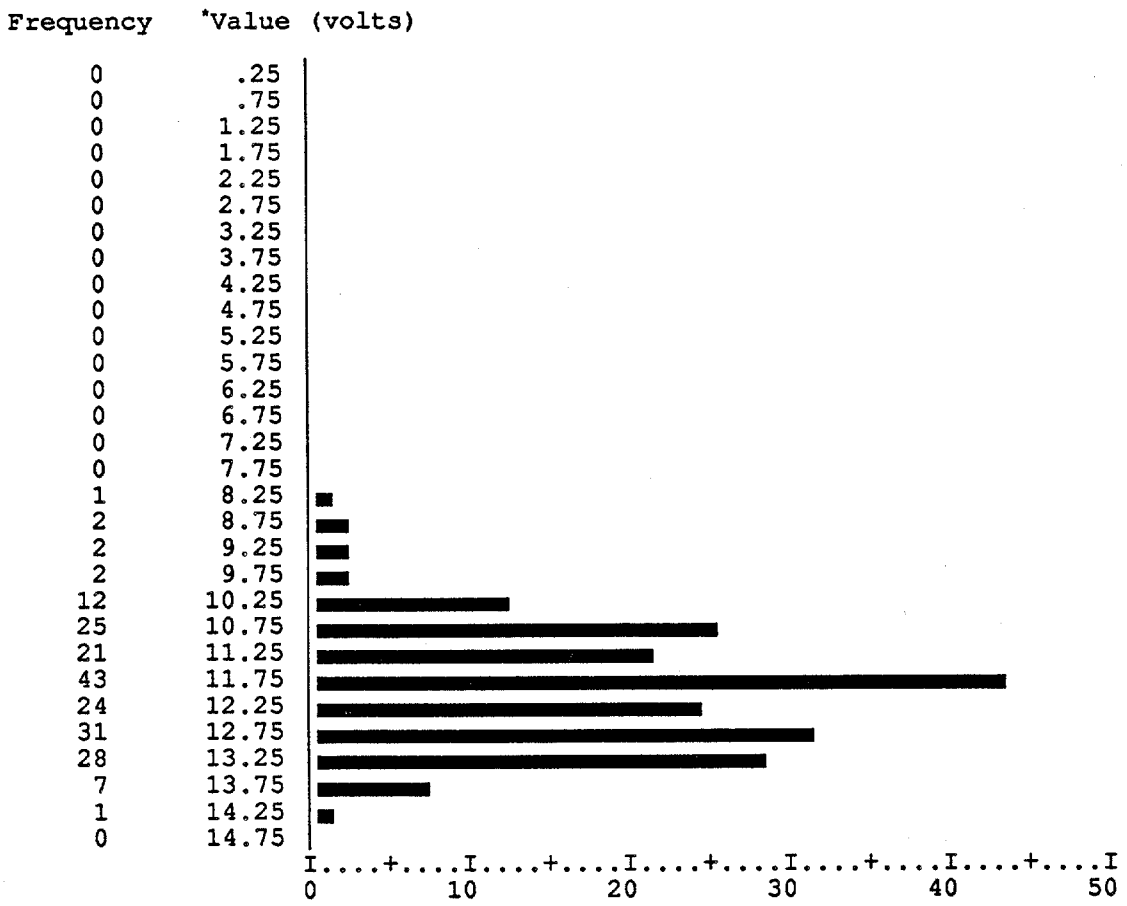
VOLTAGE READINGS AT LEFT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.17	1	.5	.5	59.9
12.21	2	1.0	1.0	60.9
12.22	1	.5	.5	61.5
12.23	1	.5	.5	62.0
12.24	1	.5	.5	62.5
12.26	1	.5	.5	63.0
12.28	1	.5	.5	63.5
12.29	1	.5	.5	64.1
12.30	1	.5	.5	64.6
12.35	1	.5	.5	65.1
12.38	1	.5	.5	65.6
12.40	2	1.0	1.0	66.7
12.41	1	.5	.5	67.2
12.47	1	.5	.5	67.7
12.50	3	1.6	1.6	69.3
12.54	2	1.0	1.0	70.3
12.55	1	.5	.5	70.8
12.57	2	1.0	1.0	71.9
12.58	1	.5	.5	72.4
12.60	1	.5	.5	72.9
12.61	1	.5	.5	73.4
12.62	1	.5	.5	74.0
12.63	1	.5	.5	74.5
12.66	1	.5	.5	75.0
12.69	1	.5	.5	75.5
12.70	2	1.0	1.0	76.6
12.76	2	1.0	1.0	77.6
12.79	1	.5	.5	78.1
12.80	1	.5	.5	78.6
12.91	1	.5	.5	79.2
12.93	2	1.0	1.0	80.2
12.94	1	.5	.5	80.7
12.96	1	.5	.5	81.3
12.97	1	.5	.5	81.8
12.99	1	.5	.5	82.3
13.00	1	.5	.5	82.8
13.01	1	.5	.5	83.3
13.03	2	1.0	1.0	84.4
13.04	1	.5	.5	84.9
13.06	1	.5	.5	85.4
13.07	1	.5	.5	85.9
13.10	1	.5	.5	86.5
13.13	4	2.1	2.1	88.5
13.16	1	.5	.5	89.1
13.28	1	.5	.5	89.6
13.29	1	.5	.5	90.1

VOLTAGE READINGS AT LEFT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.30	1	.5	.5	90.6
13.34	1	.5	.5	91.1
13.35	1	.5	.5	91.7
13.36	1	.5	.5	92.2
13.38	2	1.0	1.0	93.2
13.39	1	.5	.5	93.8
13.41	1	.5	.5	94.3
13.42	1	.5	.5	94.8
13.44	1	.5	.5	95.3
13.47	1	.5	.5	95.8
13.48	1	.5	.5	96.4
13.50	1	.5	.5	96.9
13.61	1	.5	.5	97.4
13.65	1	.5	.5	97.9
13.70	2	1.0	1.0	99.0
13.72	1	.5	.5	99.5
13.81	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT LEFT STOP LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	11.883	Std Err	.077	Median	11.930
Mode	11.800	Std Dev	1.093	Variance	1.194
Range	5.730	Minimum	8.470	Maximum	14.200

VOLTAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
9.93	1	.5	.5	.5
10.04	1	.5	.5	1.0
10.11	1	.5	.5	1.6
10.80	2	1.0	1.0	2.6
10.81	1	.5	.5	3.1
10.82	1	.5	.5	3.6
10.92	1	.5	.5	4.2
10.98	2	1.0	1.0	5.2
10.99	1	.5	.5	5.7
11.08	2	1.0	1.0	6.8
11.12	1	.5	.5	7.3
11.13	1	.5	.5	7.8
11.18	1	.5	.5	8.3
11.20	1	.5	.5	8.9
11.22	1	.5	.5	9.4
11.25	1	.5	.5	9.9
11.29	1	.5	.5	10.4
11.31	2	1.0	1.0	11.5
11.33	1	.5	.5	12.0
11.36	1	.5	.5	12.5
11.43	1	.5	.5	13.0
11.47	1	.5	.5	13.5
11.48	4	2.1	2.1	15.6
11.49	1	.5	.5	16.1
11.54	2	1.0	1.0	17.2
11.55	1	.5	.5	17.7
11.56	2	1.0	1.0	18.8
11.58	2	1.0	1.0	19.8
11.61	1	.5	.5	20.3
11.68	2	1.0	1.0	21.4
11.70	2	1.0	1.0	22.4
11.71	2	1.0	1.0	23.4
11.72	1	.5	.5	24.0
11.74	2	1.0	1.0	25.0
11.76	1	.5	.5	25.5
11.77	2	1.0	1.0	26.6
11.78	1	.5	.5	27.1
11.79	1	.5	.5	27.6
11.80	2	1.0	1.0	28.6
11.82	3	1.6	1.6	30.2
11.85	1	.5	.5	30.7
11.90	4	2.1	2.1	32.8
11.92	1	.5	.5	33.3
11.93	1	.5	.5	33.9
11.94	2	1.0	1.0	34.9

VOLTAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
11.95	1	.5	.5	35.4
11.96	1	.5	.5	35.9
11.98	1	.5	.5	36.5
12.00	3	1.6	1.6	38.0
12.01	1	.5	.5	38.5
12.02	2	1.0	1.0	39.6
12.04	3	1.6	1.6	41.1
12.05	2	1.0	1.0	42.2
12.09	2	1.0	1.0	43.2
12.10	1	.5	.5	43.8
12.12	1	.5	.5	44.3
12.15	1	.5	.5	44.8
12.16	1	.5	.5	45.3
12.17	1	.5	.5	45.8
12.19	1	.5	.5	46.4
12.21	1	.5	.5	46.9
12.22	1	.5	.5	47.4
12.23	1	.5	.5	47.9
12.24	1	.5	.5	48.4
12.25	1	.5	.5	49.0
12.26	1	.5	.5	49.5
12.27	1	.5	.5	50.0
12.28	1	.5	.5	50.5
12.30	2	1.0	1.0	51.6
12.31	1	.5	.5	52.1
12.35	1	.5	.5	52.6
12.37	2	1.0	1.0	53.6
12.41	2	1.0	1.0	54.7
12.44	1	.5	.5	55.2
12.47	2	1.0	1.0	56.3
12.50	4	2.1	2.1	58.3
12.53	1	.5	.5	58.9
12.56	1	.5	.5	59.4
12.57	2	1.0	1.0	60.4
12.58	2	1.0	1.0	61.5
12.60	3	1.6	1.6	63.0
12.62	3	1.6	1.6	64.6
12.63	1	.5	.5	65.1
12.65	2	1.0	1.0	66.1
12.66	1	.5	.5	66.7
12.67	1	.5	.5	67.2
12.68	1	.5	.5	67.7
12.70	1	.5	.5	68.2
12.72	2	1.0	1.0	69.3
12.75	1	.5	.5	69.8

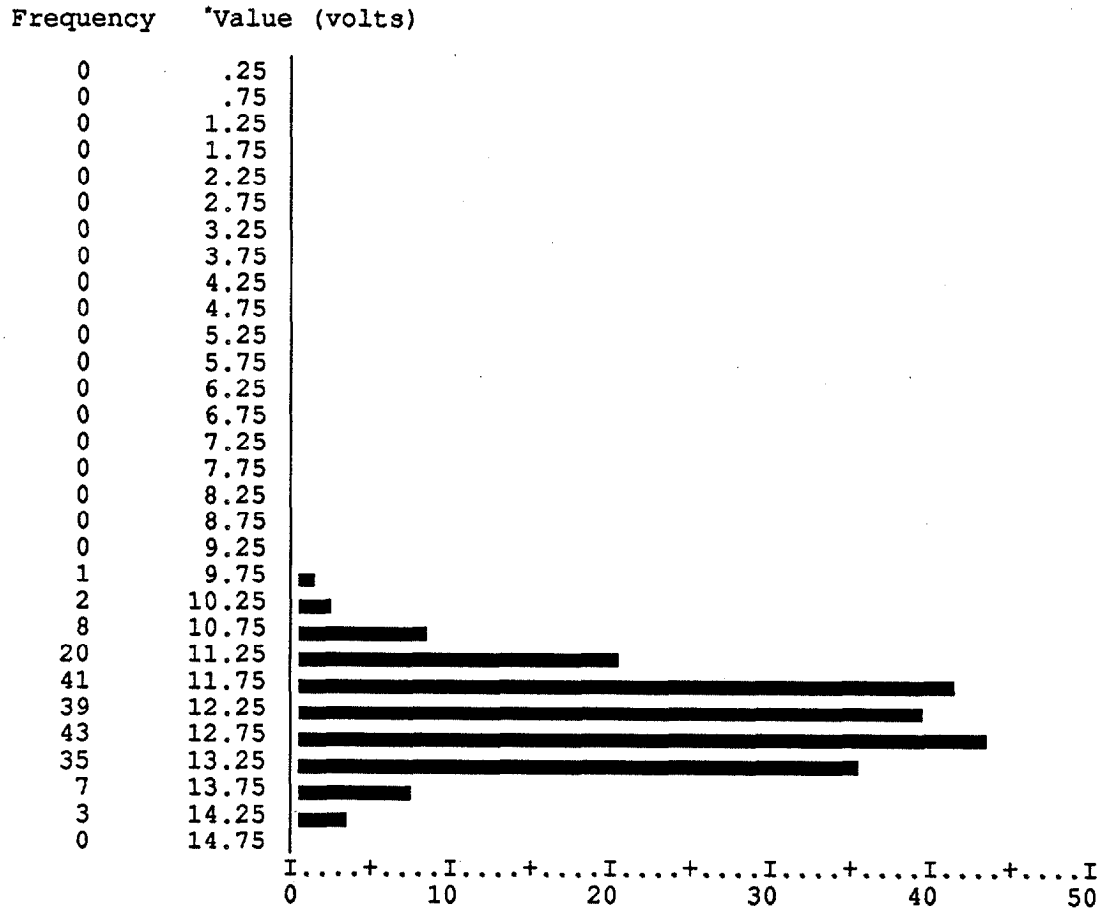
VOLTAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.76	1	.5	.5	70.3
12.82	1	.5	.5	70.8
12.83	1	.5	.5	71.4
12.84	1	.5	.5	71.9
12.85	1	.5	.5	72.4
12.88	1	.5	.5	72.9
12.89	1	.5	.5	73.4
12.90	1	.5	.5	74.0
12.91	1	.5	.5	74.5
12.93	1	.5	.5	75.0
12.94	2	1.0	1.0	76.0
12.96	1	.5	.5	76.6
12.99	1	.5	.5	77.1
13.00	1	.5	.5	77.6
13.01	2	1.0	1.0	78.6
13.02	1	.5	.5	79.2
13.03	1	.5	.5	79.7
13.04	2	1.0	1.0	80.7
13.05	1	.5	.5	81.3
13.06	1	.5	.5	81.8
13.07	1	.5	.5	82.3
13.08	1	.5	.5	82.8
13.10	3	1.6	1.6	84.4
13.12	1	.5	.5	84.9
13.13	2	1.0	1.0	85.9
13.15	1	.5	.5	86.5
13.17	1	.5	.5	87.0
13.22	1	.5	.5	87.5
13.29	3	1.6	1.6	89.1
13.30	1	.5	.5	89.6
13.32	2	1.0	1.0	90.6
13.33	1	.5	.5	91.1
13.34	1	.5	.5	91.7
13.37	2	1.0	1.0	92.7
13.39	1	.5	.5	93.2
13.41	1	.5	.5	93.8
13.42	1	.5	.5	94.3
13.44	1	.5	.5	94.8
13.47	1	.5	.5	95.3
13.49	1	.5	.5	95.8
13.53	1	.5	.5	96.4
13.61	1	.5	.5	96.9
13.65	1	.5	.5	97.4
13.68	1	.5	.5	97.9

VOLTAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.72	1	.5	.5	98.4
13.73	1	.5	.5	99.0
13.84	1	.5	.5	99.5
14.00	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT LEFT STOP LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	12.303	Std Err	.057	Median	12.300
Mode	11.480	Std Dev	.800	Variance	.639
Range	4.240	Minimum	9.930	Maximum	14.170

VOLTAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
8.50	2	1.0	1.0	1.0
8.70	1	.5	.5	1.6
9.01	1	.5	.5	2.1
9.40	1	.5	.5	2.6
9.76	1	.5	.5	3.1
9.77	1	.5	.5	3.7
9.79	1	.5	.5	4.2
9.95	1	.5	.5	4.7
9.98	1	.5	.5	5.2
10.07	1	.5	.5	5.8
10.13	1	.5	.5	6.3
10.14	1	.5	.5	6.8
10.21	1	.5	.5	7.3
10.25	1	.5	.5	7.9
10.30	1	.5	.5	8.4
10.31	1	.5	.5	8.9
10.37	1	.5	.5	9.4
10.38	2	1.0	1.0	10.5
10.40	2	1.0	1.0	11.5
10.42	1	.5	.5	12.0
10.44	2	1.0	1.0	13.1
10.48	1	.5	.5	13.6
10.57	1	.5	.5	14.1
10.58	1	.5	.5	14.7
10.63	2	1.0	1.0	15.7
10.70	1	.5	.5	16.2
10.74	1	.5	.5	16.8
10.76	1	.5	.5	17.3
10.77	1	.5	.5	17.8
10.79	1	.5	.5	18.3
10.80	2	1.0	1.0	19.4
10.85	2	1.0	1.0	20.4
10.86	1	.5	.5	20.9
10.90	2	1.0	1.0	22.0
10.91	1	.5	.5	22.5
10.92	1	.5	.5	23.0
10.94	1	.5	.5	23.6
11.00	2	1.0	1.0	24.6
11.01	2	1.0	1.0	25.7
11.05	1	.5	.5	26.2

VOLTAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
11.06	1	.5	.5	26.7
11.18	1	.5	.5	27.2
11.20	1	.5	.5	27.7
11.21	1	.5	.5	28.3
11.26	2	1.0	1.0	29.3
11.30	2	1.0	1.0	30.4
11.32	1	.5	.5	30.9
11.33	1	.5	.5	31.4
11.37	1	.5	.5	31.9
11.40	3	1.6	1.6	33.5
11.45	1	.5	.5	34.0
11.46	1	.5	.5	34.6
11.48	1	.5	.5	35.1
11.50	3	1.6	1.6	36.6
11.58	1	.5	.5	37.2
11.59	2	1.0	1.0	38.2
11.60	1	.5	.5	38.7
11.63	1	.5	.5	39.3
11.67	1	.5	.5	39.8
11.70	1	.5	.5	40.3
11.74	1	.5	.5	40.8
11.75	1	.5	.5	41.4
11.76	1	.5	.5	41.9
11.82	1	.5	.5	42.4
11.83	3	1.6	1.6	44.0
11.86	1	.5	.5	44.5
11.87	2	1.0	1.0	45.5
11.89	4	2.1	2.1	47.6
11.90	3	1.6	1.6	49.2
11.91	1	.5	.5	49.7
11.92	1	.5	.5	50.3
11.94	1	.5	.5	50.8
11.95	4	2.1	2.1	52.9
11.98	1	.5	.5	53.4
12.02	1	.5	.5	53.9
12.06	2	1.0	1.0	55.0
12.07	1	.5	.5	55.5
12.09	1	.5	.5	56.0
12.10	3	1.6	1.6	57.6
12.11	1	.5	.5	58.1
12.14	1	.5	.5	58.6
12.15	1	.5	.5	59.2
12.17	1	.5	.5	59.7
12.19	1	.5	.5	60.2

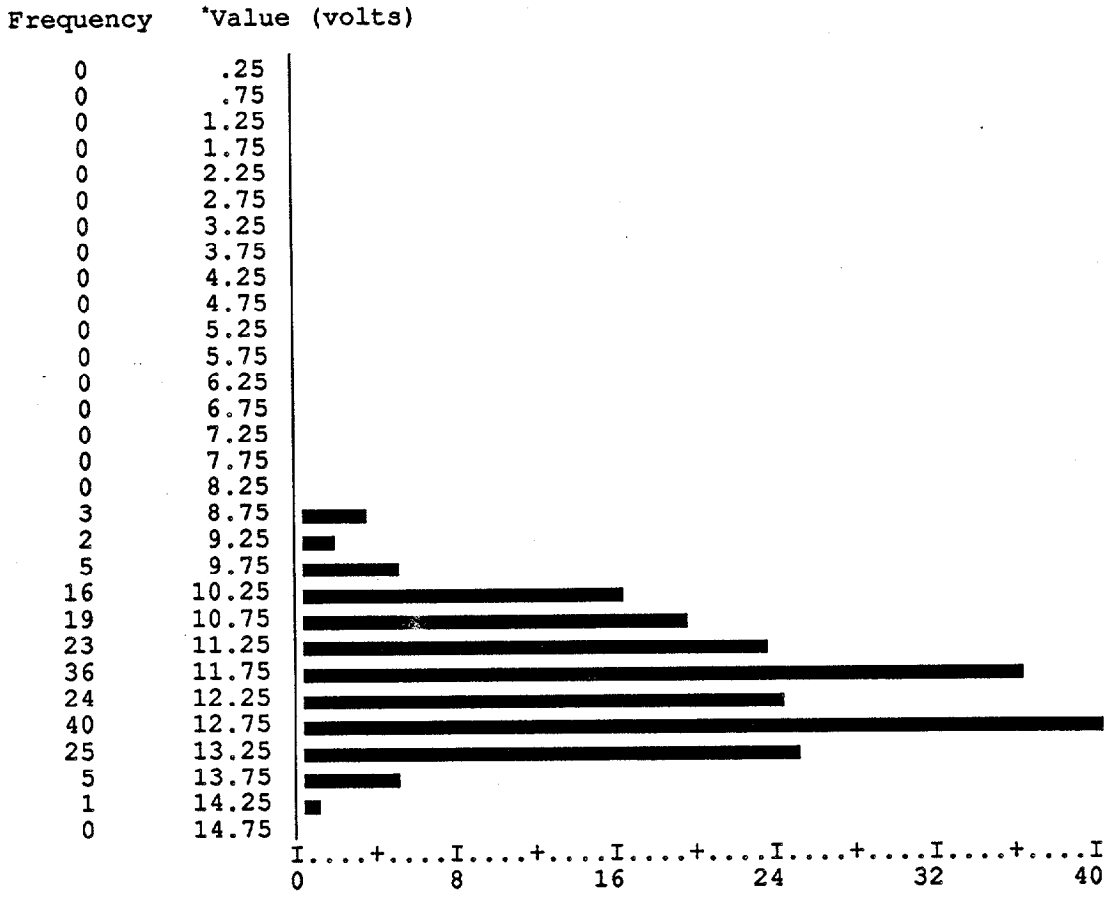
VOLTAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.21	1	.5	.5	60.7
12.22	2	1.0	1.0	61.8
12.25	1	.5	.5	62.3
12.30	1	.5	.5	62.8
12.35	1	.5	.5	63.4
12.39	2	1.0	1.0	64.4
12.45	1	.5	.5	64.9
12.48	1	.5	.5	65.4
12.50	5	2.6	2.6	68.1
12.54	1	.5	.5	68.6
12.55	2	1.0	1.0	69.6
12.58	2	1.0	1.0	70.7
12.59	1	.5	.5	71.2
12.60	2	1.0	1.0	72.3
12.61	1	.5	.5	72.8
12.62	1	.5	.5	73.3
12.66	1	.5	.5	73.8
12.70	2	1.0	1.0	74.9
12.72	1	.5	.5	75.4
12.75	1	.5	.5	75.9
12.79	1	.5	.5	76.4
12.80	3	1.6	1.6	78.0
12.82	1	.5	.5	78.5
12.85	1	.5	.5	79.1
12.88	2	1.0	1.0	80.1
12.89	1	.5	.5	80.6
12.90	1	.5	.5	81.2
12.92	1	.5	.5	81.7
12.95	2	1.0	1.0	82.7
12.97	2	1.0	1.0	83.8
12.99	2	1.0	1.0	84.8
13.00	2	1.0	1.0	85.9
13.01	1	.5	.5	86.4
13.05	1	.5	.5	86.9
13.06	2	1.0	1.0	88.0
13.09	1	.5	.5	88.5
13.11	1	.5	.5	89.0
13.13	1	.5	.5	89.5
13.15	1	.5	.5	90.1
13.16	2	1.0	1.0	91.1
13.25	1	.5	.5	91.6
13.27	1	.5	.5	92.1
13.28	1	.5	.5	92.7
13.30	1	.5	.5	93.2

VOLTAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.32	1	.5	.5	93.7
13.34	3	1.6	1.6	95.3
13.42	1	.5	.5	95.8
13.44	1	.5	.5	96.3
13.49	2	1.0	1.0	97.4
13.51	1	.5	.5	97.9
13.52	1	.5	.5	98.4
13.58	1	.5	.5	99.0
13.60	1	.5	.5	99.5
13.66	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT RIGHT STOP LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	11.865	Std Err	.078	Median	11.950
Mode	12.500	Std Dev	1.096	Variance	1.200
Range	5.600	Minimum	8.500	Maximum	14.100

VOLTAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
9.85	1	.5	.5	.5
9.97	1	.5	.5	1.0
10.49	1	.5	.5	1.6
10.60	1	.5	.5	2.1
10.64	1	.5	.5	2.6
10.78	3	1.6	1.6	4.2
10.84	1	.5	.5	4.7
10.87	1	.5	.5	5.2
10.92	1	.5	.5	5.8
10.93	1	.5	.5	6.3
10.97	2	1.0	1.0	7.3
11.05	1	.5	.5	7.9
11.06	1	.5	.5	8.4
11.09	1	.5	.5	8.9
11.13	1	.5	.5	9.4
11.20	1	.5	.5	9.9
11.25	1	.5	.5	10.5
11.26	1	.5	.5	11.0
11.30	1	.5	.5	11.5
11.37	1	.5	.5	12.0
11.38	1	.5	.5	12.6
11.40	4	2.1	2.1	14.7
11.42	1	.5	.5	15.2
11.44	1	.5	.5	15.7
11.48	1	.5	.5	16.2
11.49	1	.5	.5	16.8
11.50	3	1.6	1.6	18.3
11.51	1	.5	.5	18.8
11.52	1	.5	.5	19.4
11.54	1	.5	.5	19.9
11.59	1	.5	.5	20.4
11.63	1	.5	.5	20.9
11.64	1	.5	.5	21.5
11.67	2	1.0	1.0	22.5
11.72	3	1.6	1.6	24.1
11.73	2	1.0	1.0	25.1
11.74	2	1.0	1.0	26.2
11.75	1	.5	.5	26.7
11.78	1	.5	.5	27.2
11.79	1	.5	.5	27.7

VOLTAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE (continued)

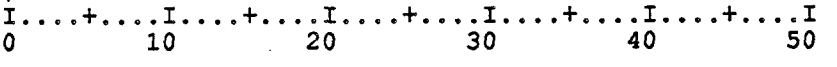
Value	Frequency	Percent	Valid Percent	Cum Percent
11.80	2	1.0	1.0	28.8
11.85	1	.5	.5	29.3
11.89	3	1.6	1.6	30.9
11.90	3	1.6	1.6	32.5
11.92	1	.5	.5	33.0
11.93	1	.5	.5	33.5
11.94	2	1.0	1.0	34.6
11.96	1	.5	.5	35.1
11.97	2	1.0	1.0	36.1
11.99	2	1.0	1.0	37.2
12.00	1	.5	.5	37.7
12.02	2	1.0	1.0	38.7
12.05	5	2.6	2.6	41.4
12.06	1	.5	.5	41.9
12.07	2	1.0	1.0	42.9
12.09	1	.5	.5	43.5
12.10	2	1.0	1.0	44.5
12.11	1	.5	.5	45.0
12.14	2	1.0	1.0	46.1
12.15	1	.5	.5	46.6
12.18	1	.5	.5	47.1
12.19	1	.5	.5	47.6
12.20	4	2.1	2.1	49.7
12.21	2	1.0	1.0	50.8
12.27	1	.5	.5	51.3
12.28	1	.5	.5	51.8
12.37	1	.5	.5	52.4
12.38	1	.5	.5	52.9
12.39	3	1.6	1.6	54.5
12.40	1	.5	.5	55.0
12.42	1	.5	.5	55.5
12.44	1	.5	.5	56.0
12.48	1	.5	.5	56.5
12.49	1	.5	.5	57.1
12.50	4	2.1	2.1	59.2
12.52	1	.5	.5	59.7
12.53	2	1.0	1.0	60.7
12.54	1	.5	.5	61.3
12.55	1	.5	.5	61.8
12.59	1	.5	.5	62.3
12.61	4	2.1	2.1	64.4
12.66	1	.5	.5	64.9
12.67	3	1.6	1.6	66.5
12.68	1	.5	.5	67.0

VOLTAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.69	1	.5	.5	67.5
12.70	1	.5	.5	68.1
12.71	1	.5	.5	68.6
12.74	1	.5	.5	69.1
12.75	1	.5	.5	69.6
12.79	1	.5	.5	70.2
12.81	2	1.0	1.0	71.2
12.82	5	2.6	2.6	73.8
12.84	1	.5	.5	74.3
12.89	1	.5	.5	74.9
12.90	1	.5	.5	75.4
12.91	4	2.1	2.1	77.5
12.92	1	.5	.5	78.0
12.95	1	.5	.5	78.5
12.96	1	.5	.5	79.1
12.97	1	.5	.5	79.6
12.99	3	1.6	1.6	81.2
13.00	3	1.6	1.6	82.7
13.01	1	.5	.5	83.2
13.02	1	.5	.5	83.8
13.03	1	.5	.5	84.3
13.08	1	.5	.5	84.8
13.09	2	1.0	1.0	85.9
13.10	1	.5	.5	86.4
13.11	1	.5	.5	86.9
13.16	2	1.0	1.0	88.0
13.17	2	1.0	1.0	89.0
13.19	1	.5	.5	89.5
13.20	2	1.0	1.0	90.6
13.26	1	.5	.5	91.1
13.28	1	.5	.5	91.6
13.31	2	1.0	1.0	92.7
13.34	1	.5	.5	93.2
13.35	1	.5	.5	93.7
13.37	2	1.0	1.0	94.8
13.40	1	.5	.5	95.3
13.44	1	.5	.5	95.8
13.49	2	1.0	1.0	96.9
13.51	1	.5	.5	97.4
13.54	2	1.0	1.0	98.4
13.59	1	.5	.5	99.0
13.61	1	.5	.5	99.5
13.68	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT RIGHT STOP LAMP AT HIGH IDLE (continued)

Frequency	*Value (volts)
0	.25
0	.75
0	1.25
0	1.75
0	2.25
0	2.75
0	3.25
0	3.75
0	4.25
0	4.75
0	5.25
0	5.75
0	6.25
0	6.75
0	7.25
0	7.75
0	8.25
0	8.75
0	9.25
2	9.75
1	10.25
11	10.75
19	11.25
40	11.75
39	12.25
48	12.75
31	13.25
6	13.75
2	14.25
0	14.75



Frequency of Readings

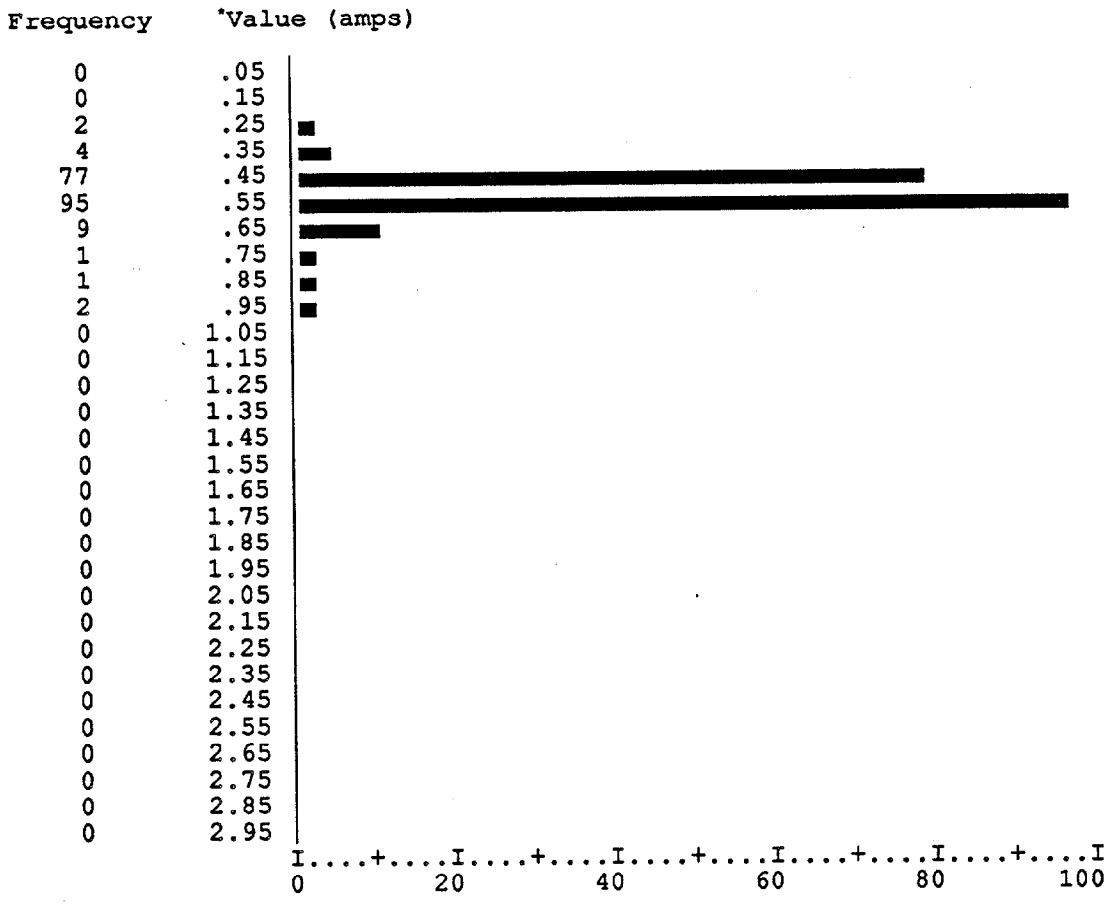
* Values are presented at intervals of .50 volts

Mean	12.268	Std Err	.056	Median	12.210
Mode	12.050	Std Dev	.787	Variance	.619
Range	4.190	Minimum	9.850	Maximum	14.040

AMPERAGE READINGS AT LEFT PRESENCE LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
.26	1	.5	.5	.5
.30	1	.5	.5	1.0
.34	1	.5	.5	1.6
.36	1	.5	.5	2.1
.37	1	.5	.5	2.6
.39	1	.5	.5	3.1
.40	3	1.6	1.6	4.7
.41	3	1.6	1.6	6.3
.42	3	1.6	1.6	7.9
.43	6	3.1	3.1	11.0
.44	11	5.7	5.8	16.8
.45	4	2.1	2.1	18.8
.46	5	2.6	2.6	21.5
.47	12	6.3	6.3	27.7
.48	6	3.1	3.1	30.9
.49	8	4.2	4.2	35.1
.50	16	8.3	8.4	43.5
.51	11	5.7	5.8	49.2
.52	14	7.3	7.3	56.5
.53	4	2.1	2.1	58.6
.54	2	1.0	1.0	59.7
.55	22	11.5	11.5	71.2
.56	19	9.9	9.9	81.2
.57	7	3.6	3.7	84.8
.58	6	3.1	3.1	88.0
.59	3	1.6	1.6	89.5
.60	7	3.6	3.7	93.2
.61	4	2.1	2.1	95.3
.62	2	1.0	1.0	96.3
.64	1	.5	.5	96.9
.65	2	1.0	1.0	97.9
.76	1	.5	.5	98.4
.82	1	.5	.5	99.0
.92	1	.5	.5	99.5
.96	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT LEFT PRESENCE LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .10 amps

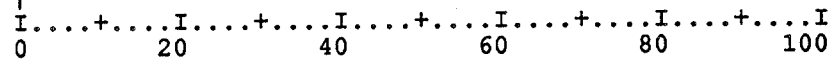
Mean	.518	Std Err	.006	Median	.520
Mode	.550	Std Dev	.082	Variance	.007
Range	.700	Minimum	.260	Maximum	.960

AMPERAGE READINGS AT LEFT PRESENCE LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
.26	1	.5	.5	.5
.30	2	1.0	1.0	1.6
.36	1	.5	.5	2.1
.37	1	.5	.5	2.6
.39	1	.5	.5	3.1
.40	3	1.6	1.6	4.7
.41	2	1.0	1.0	5.8
.42	2	1.0	1.0	6.8
.43	6	3.1	3.1	9.9
.44	7	3.6	3.7	13.6
.45	13	6.8	6.8	20.4
.46	1	.5	.5	20.9
.47	9	4.7	4.7	25.7
.48	6	3.1	3.1	28.8
.49	10	5.2	5.2	34.0
.50	14	7.3	7.3	41.4
.51	10	5.2	5.2	46.6
.52	8	4.2	4.2	50.8
.53	8	4.2	4.2	55.0
.54	2	1.0	1.0	56.0
.55	13	6.8	6.8	62.8
.56	16	8.3	8.4	71.2
.57	17	8.9	8.9	80.1
.58	11	5.7	5.8	85.9
.59	6	3.1	3.1	89.0
.60	5	2.6	2.6	91.6
.61	5	2.6	2.6	94.2
.62	4	2.1	2.1	96.3
.64	1	.5	.5	96.9
.65	2	1.0	1.0	97.9
.76	1	.5	.5	98.4
.82	1	.5	.5	99.0
.92	1	.5	.5	99.5
.97	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT LEFT PRESENCE LAMP AT HIGH IDLE (continued)

Frequency	*Value (amps)
0	.05
0	.15
3	.25
3	.35
73	.45
96	.55
12	.65
1	.75
1	.85
2	.95
0	1.05
0	1.15
0	1.25
0	1.35
0	1.45
0	1.55
0	1.65
0	1.75
0	1.85
0	1.95
0	2.05
0	2.15
0	2.25
0	2.35
0	2.45
0	2.55
0	2.65
0	2.75
0	2.85
0	2.95



Frequency of Readings

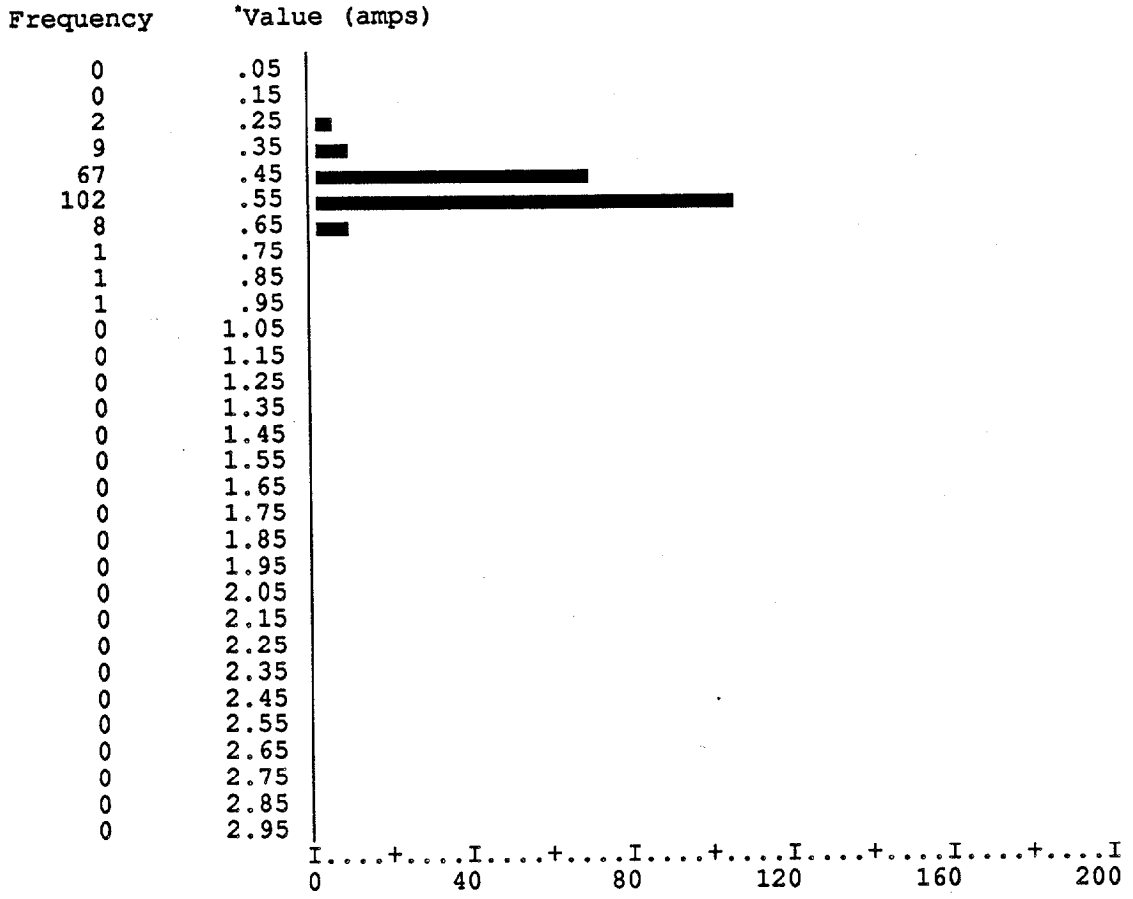
* Values are presented at intervals of .10 amps

Mean	.524	Std Err	.006	Median	.520
Mode	.570	Std Dev	.084	Variance	.007
Range	.710	Minimum	.260	Maximum	.970

AMPERAGE READINGS AT RIGHT PRESENCE LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
.28	2	1.0	1.0	1.0
.31	2	1.0	1.0	2.1
.36	1	.5	.5	2.6
.37	1	.5	.5	3.1
.38	2	1.0	1.0	4.2
.39	3	1.6	1.6	5.8
.40	4	2.1	2.1	7.9
.41	3	1.6	1.6	9.4
.42	4	2.1	2.1	11.5
.43	6	3.1	3.1	14.7
.44	7	3.6	3.7	18.3
.45	4	2.1	2.1	20.4
.46	8	4.2	4.2	24.6
.47	7	3.6	3.7	28.3
.48	5	2.6	2.6	30.9
.49	7	3.6	3.7	34.6
.50	12	6.3	6.3	40.8
.51	7	3.6	3.7	44.5
.52	7	3.6	3.7	48.2
.53	6	3.1	3.1	51.3
.54	6	3.1	3.1	54.5
.55	31	16.1	16.2	70.7
.56	22	11.5	11.5	82.2
.57	9	4.7	4.7	86.9
.58	6	3.1	3.1	90.1
.59	4	2.1	2.1	92.1
.60	4	2.1	2.1	94.2
.61	3	1.6	1.6	95.8
.62	1	.5	.5	96.3
.63	2	1.0	1.0	97.4
.64	1	.5	.5	97.9
.65	1	.5	.5	98.4
.72	1	.5	.5	99.0
.85	1	.5	.5	99.5
.94	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT RIGHT PRESENCE LAMP AT LOW IDLE (continued)



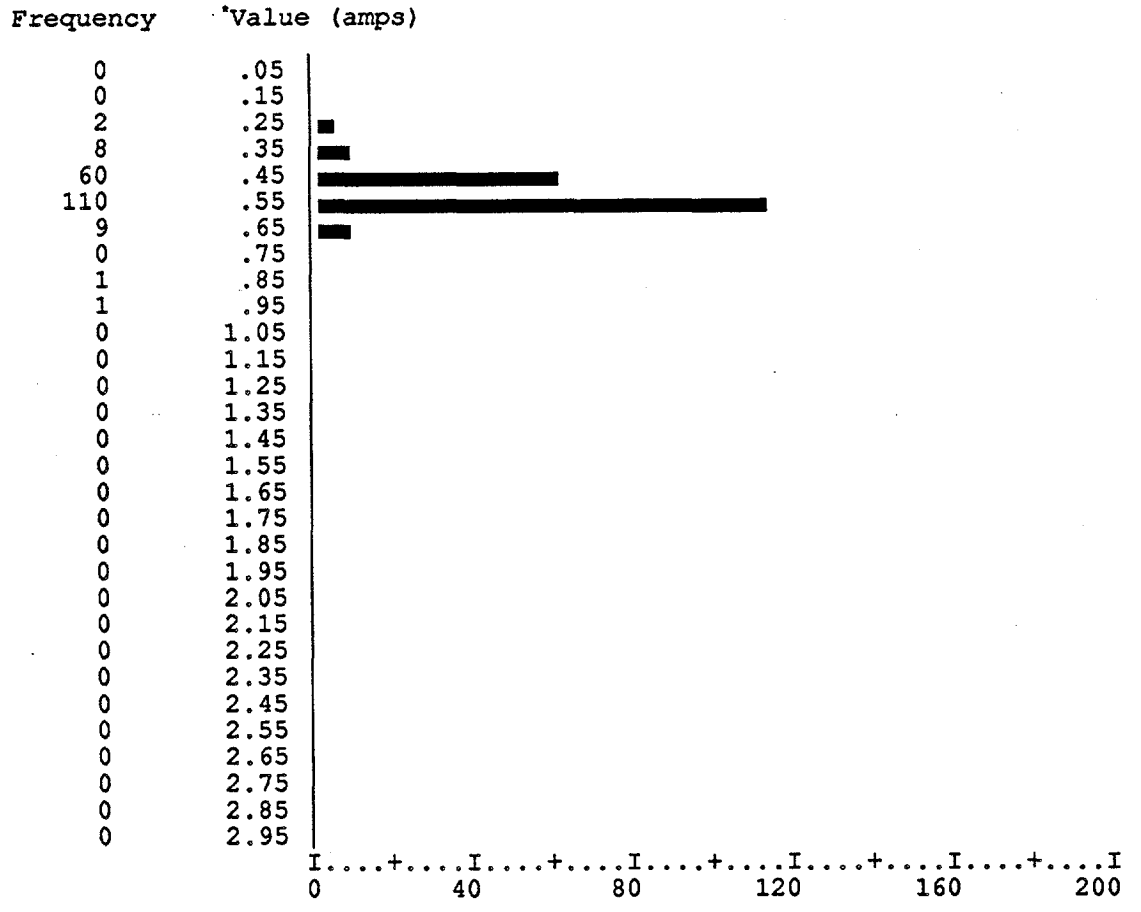
* Values are presented at intervals of .10 amps

Mean	.516	Std Err	.006	Median	.530
Mode	.550	Std Dev	.080	Variance	.006
Range	.660	Minimum	.280	Maximum	.940

AMPERAGE READINGS AT RIGHT PRESENCE LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
.28	2	1.0	1.0	1.0
.31	1	.5	.5	1.6
.32	1	.5	.5	2.1
.36	1	.5	.5	2.6
.37	2	1.0	1.0	3.7
.39	3	1.6	1.6	5.2
.40	3	1.6	1.6	6.8
.41	4	2.1	2.1	8.9
.42	3	1.6	1.6	10.5
.43	6	3.1	3.1	13.6
.44	6	3.1	3.1	16.8
.45	4	2.1	2.1	18.8
.46	8	4.2	4.2	23.0
.47	10	5.2	5.2	28.3
.48	4	2.1	2.1	30.4
.49	7	3.6	3.7	34.0
.50	5	2.6	2.6	36.6
.51	3	1.6	1.6	38.2
.52	11	5.7	5.8	44.0
.53	7	3.6	3.7	47.6
.54	4	2.1	2.1	49.7
.55	26	13.5	13.6	63.4
.56	22	11.5	11.5	74.9
.57	16	8.3	8.4	83.2
.58	10	5.2	5.2	88.5
.59	7	3.6	3.7	92.1
.60	4	2.1	2.1	94.2
.61	2	1.0	1.0	95.3
.62	2	1.0	1.0	96.3
.63	2	1.0	1.0	97.4
.65	1	.5	.5	97.9
.66	1	.5	.5	98.4
.70	1	.5	.5	99.0
.85	1	.5	.5	99.5
.94	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT RIGHT PRESENCE LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .10 amps

Mean	.521	Std Err	.006	Median	.550
Mode	.550	Std Dev	.080	Variance	.006
Range	.660	Minimum	.280	Maximum	.940

VOLTAGE READINGS AT LEFT PRESENCE LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
10.32	1	.5	.5	.5
10.53	2	1.0	1.0	1.6
10.55	1	.5	.5	2.1
10.66	1	.5	.5	2.6
10.86	1	.5	.5	3.1
10.90	1	.5	.5	3.6
10.95	1	.5	.5	4.2
11.25	2	1.0	1.0	5.2
11.26	1	.5	.5	5.7
11.27	1	.5	.5	6.3
11.31	1	.5	.5	6.8
11.38	1	.5	.5	7.3
11.40	2	1.0	1.0	8.3
11.41	1	.5	.5	8.9
11.44	2	1.0	1.0	9.9
11.47	2	1.0	1.0	10.9
11.59	1	.5	.5	11.5
11.60	2	1.0	1.0	12.5
11.70	3	1.6	1.6	14.1
11.71	1	.5	.5	14.6
11.74	2	1.0	1.0	15.6
11.76	2	1.0	1.0	16.7
11.83	1	.5	.5	17.2
11.86	1	.5	.5	17.7
11.90	1	.5	.5	18.2
11.91	1	.5	.5	18.8
11.94	1	.5	.5	19.3
11.97	1	.5	.5	19.8
12.00	1	.5	.5	20.3
12.01	1	.5	.5	20.8
12.02	1	.5	.5	21.4
12.08	1	.5	.5	21.9
12.10	1	.5	.5	22.4
12.14	2	1.0	1.0	23.4
12.19	1	.5	.5	24.0
12.20	1	.5	.5	24.5
12.25	1	.5	.5	25.0
12.30	1	.5	.5	25.5
12.34	1	.5	.5	26.0
12.45	1	.5	.5	26.6
12.47	1	.5	.5	27.1
12.50	5	2.6	2.6	29.7
12.51	1	.5	.5	30.2
12.52	1	.5	.5	30.7

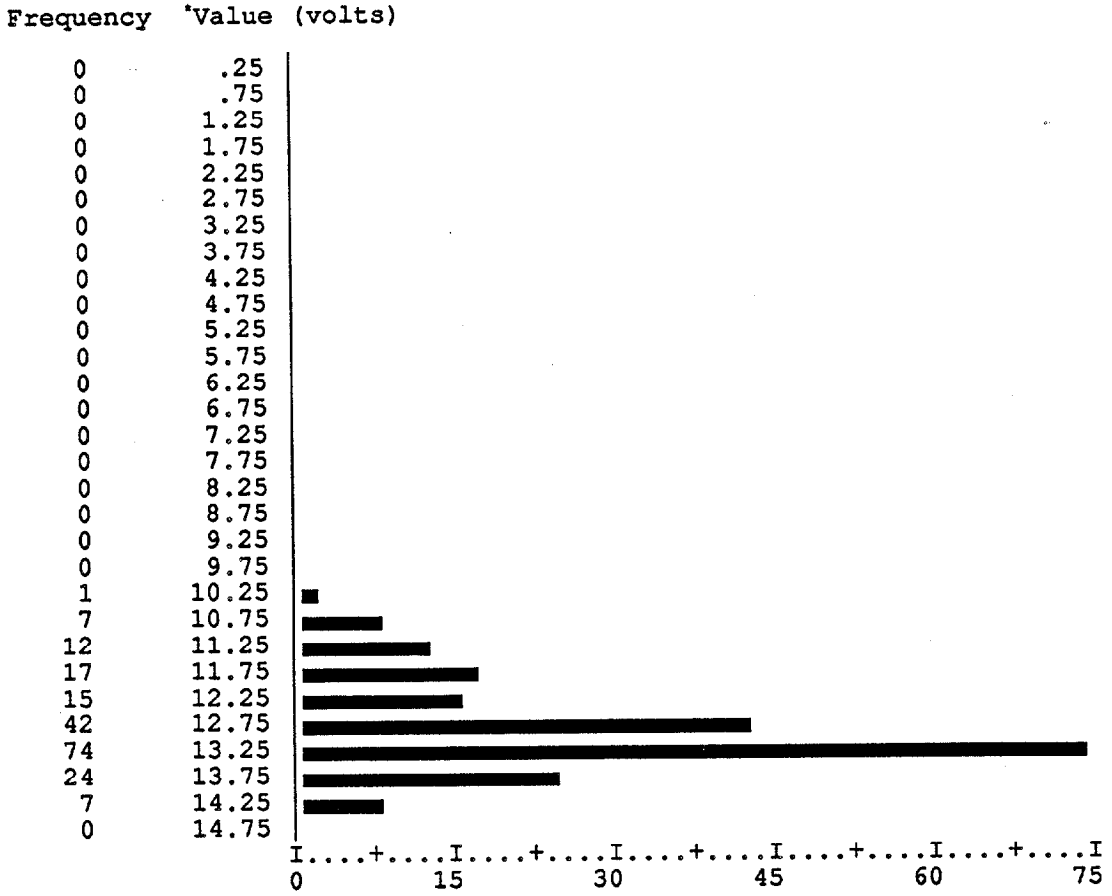
VOLTAGE READINGS AT LEFT PRESENCE LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.54	1	.5	.5	31.3
12.59	1	.5	.5	31.8
12.60	1	.5	.5	32.3
12.63	2	1.0	1.0	33.3
12.64	1	.5	.5	33.9
12.65	1	.5	.5	34.4
12.66	1	.5	.5	34.9
12.67	1	.5	.5	35.4
12.68	1	.5	.5	35.9
12.69	1	.5	.5	36.5
12.70	1	.5	.5	37.0
12.72	1	.5	.5	37.5
12.74	1	.5	.5	38.0
12.75	2	1.0	1.0	39.1
12.76	2	1.0	1.0	40.1
12.77	2	1.0	1.0	41.1
12.80	2	1.0	1.0	42.2
12.81	1	.5	.5	42.7
12.82	1	.5	.5	43.2
12.83	1	.5	.5	43.8
12.85	2	1.0	1.0	44.8
12.87	1	.5	.5	45.3
12.91	1	.5	.5	45.8
12.92	1	.5	.5	46.4
12.95	2	1.0	1.0	47.4
12.97	1	.5	.5	47.9
12.98	2	1.0	1.0	49.0
13.00	2	1.0	1.0	50.0
13.01	4	2.1	2.1	52.1
13.02	1	.5	.5	52.6
13.04	1	.5	.5	53.1
13.05	2	1.0	1.0	54.2
13.06	2	1.0	1.0	55.2
13.07	3	1.6	1.6	56.8
13.08	3	1.6	1.6	58.3
13.09	2	1.0	1.0	59.4
13.10	4	2.1	2.1	61.5
13.11	2	1.0	1.0	62.5
13.13	1	.5	.5	63.0
13.14	1	.5	.5	63.5
13.16	1	.5	.5	64.1
13.17	1	.5	.5	64.6
13.20	3	1.6	1.6	66.1
13.21	1	.5	.5	66.7

VOLTAGE READINGS AT LEFT PRESENCE LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.22	3	1.6	1.6	68.2
13.24	3	1.6	1.6	69.8
13.26	3	1.6	1.6	71.4
13.27	1	.5	.5	71.9
13.28	1	.5	.5	72.4
13.29	1	.5	.5	72.9
13.30	3	1.6	1.6	74.5
13.31	1	.5	.5	75.0
13.32	2	1.0	1.0	76.0
13.33	1	.5	.5	76.6
13.34	3	1.6	1.6	78.1
13.37	2	1.0	1.0	79.2
13.38	1	.5	.5	79.7
13.42	2	1.0	1.0	80.7
13.43	1	.5	.5	81.3
13.44	1	.5	.5	81.8
13.46	3	1.6	1.6	83.3
13.48	2	1.0	1.0	84.4
13.50	5	2.6	2.6	87.0
13.52	1	.5	.5	87.5
13.54	2	1.0	1.0	88.5
13.62	1	.5	.5	89.1
13.65	1	.5	.5	89.6
13.70	1	.5	.5	90.1
13.71	1	.5	.5	90.6
13.72	1	.5	.5	91.1
13.73	2	1.0	1.0	92.2
13.76	1	.5	.5	92.7
13.77	1	.5	.5	93.2
13.80	1	.5	.5	93.8
13.81	1	.5	.5	94.3
13.88	1	.5	.5	94.8
13.89	1	.5	.5	95.3
13.91	1	.5	.5	95.8
13.93	1	.5	.5	96.4
13.99	1	.5	.5	96.9
14.00	1	.5	.5	97.4
14.01	1	.5	.5	97.9
14.04	1	.5	.5	98.4
14.09	1	.5	.5	99.0
14.17	1	.5	.5	99.5
14.19	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT LEFT PRESENCE LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	12.783	Std Err	.058	Median	13.010
Mode	12.500	Std Dev	.819	Variance	.671
Range	3.870	Minimum	10.320	Maximum	14.190

VOLTAGE READINGS AT LEFT PRESENCE LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
10.82	1	.5	.5	.5
10.89	1	.5	.5	1.0
11.20	1	.5	.5	1.6
11.31	1	.5	.5	2.1
11.32	1	.5	.5	2.6
11.34	1	.5	.5	3.1
11.58	1	.5	.5	3.6
11.75	1	.5	.5	4.2
11.76	1	.5	.5	4.7
11.80	1	.5	.5	5.2
11.85	1	.5	.5	5.7
11.89	1	.5	.5	6.3
12.02	2	1.0	1.0	7.3
12.11	1	.5	.5	7.8
12.12	1	.5	.5	8.3
12.15	1	.5	.5	8.9
12.20	2	1.0	1.0	9.9
12.21	1	.5	.5	10.4
12.34	2	1.0	1.0	11.5
12.46	1	.5	.5	12.0
12.47	2	1.0	1.0	13.0
12.50	1	.5	.5	13.5
12.52	1	.5	.5	14.1
12.53	1	.5	.5	14.6
12.55	1	.5	.5	15.1
12.59	1	.5	.5	15.6
12.60	1	.5	.5	16.1
12.62	2	1.0	1.0	17.2
12.64	1	.5	.5	17.7
12.65	2	1.0	1.0	18.8
12.68	2	1.0	1.0	19.8
12.69	1	.5	.5	20.3
12.70	2	1.0	1.0	21.4
12.72	2	1.0	1.0	22.4
12.73	2	1.0	1.0	23.4
12.74	2	1.0	1.0	24.5
12.77	2	1.0	1.0	25.5
12.78	3	1.6	1.6	27.1
12.79	2	1.0	1.0	28.1
12.80	1	.5	.5	28.6
12.84	2	1.0	1.0	29.7
12.86	3	1.6	1.6	31.3
12.87	1	.5	.5	31.8
12.88	1	.5	.5	32.3

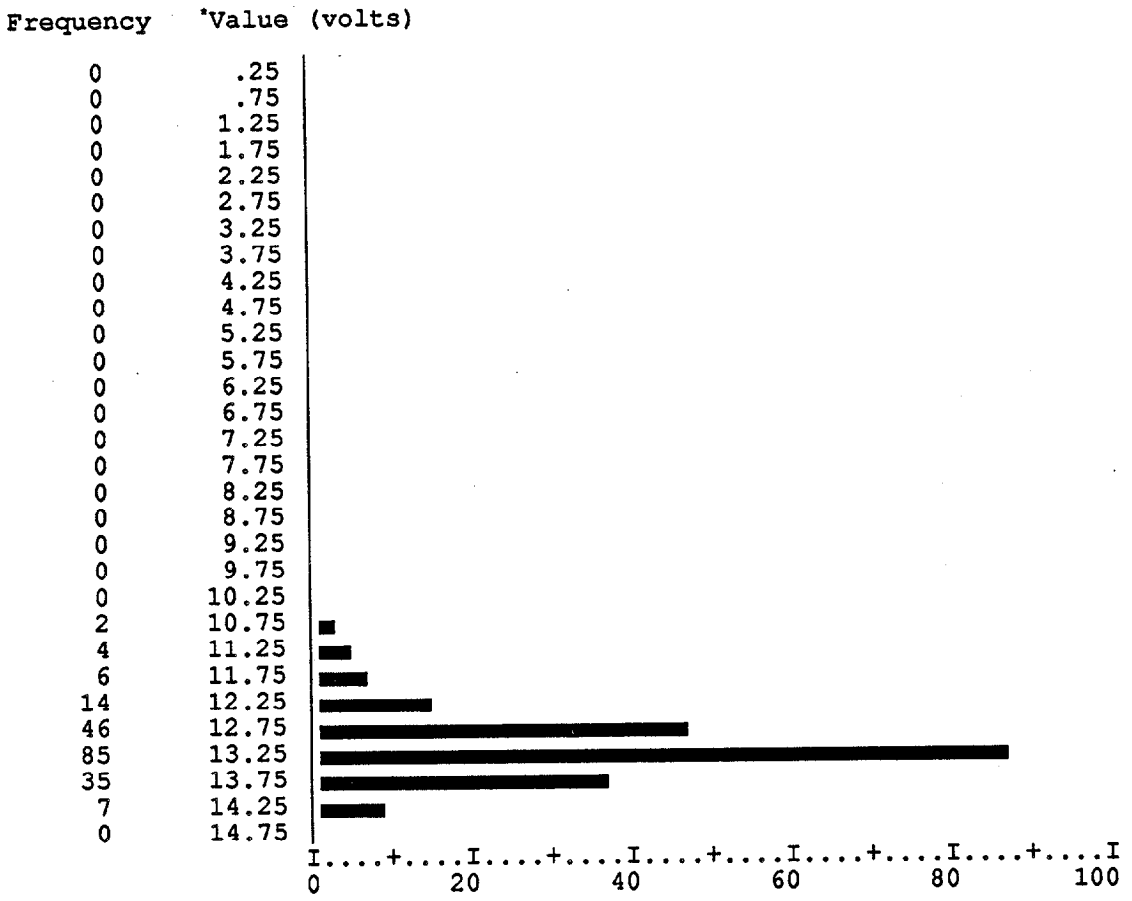
VOLTAGE READINGS AT LEFT PRESENCE LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.89	2	1.0	1.0	33.3
12.91	1	.5	.5	33.9
12.93	1	.5	.5	34.4
12.97	1	.5	.5	34.9
12.98	1	.5	.5	35.4
12.99	3	1.6	1.6	37.0
13.00	1	.5	.5	37.5
13.01	2	1.0	1.0	38.5
13.03	1	.5	.5	39.1
13.04	2	1.0	1.0	40.1
13.05	2	1.0	1.0	41.1
13.06	4	2.1	2.1	43.2
13.07	1	.5	.5	43.8
13.08	3	1.6	1.6	45.3
13.09	2	1.0	1.0	46.4
13.10	4	2.1	2.1	48.4
13.11	1	.5	.5	49.0
13.13	3	1.6	1.6	50.5
13.14	1	.5	.5	51.0
13.15	1	.5	.5	51.6
13.16	1	.5	.5	52.1
13.17	3	1.6	1.6	53.6
13.19	1	.5	.5	54.2
13.20	4	2.1	2.1	56.3
13.21	3	1.6	1.6	57.8
13.22	1	.5	.5	58.3
13.24	2	1.0	1.0	59.4
13.25	1	.5	.5	59.9
13.26	5	2.6	2.6	62.5
13.28	1	.5	.5	63.0
13.29	1	.5	.5	63.5
13.30	4	2.1	2.1	65.6
13.31	3	1.6	1.6	67.2
13.33	2	1.0	1.0	68.2
13.34	3	1.6	1.6	69.8
13.36	3	1.6	1.6	71.4
13.37	2	1.0	1.0	72.4
13.38	1	.5	.5	72.9
13.40	1	.5	.5	73.4
13.41	3	1.6	1.6	75.0
13.44	1	.5	.5	75.5
13.45	3	1.6	1.6	77.1
13.46	2	1.0	1.0	78.1
13.47	1	.5	.5	78.6

VOLTAGE READINGS AT LEFT PRESENCE LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.48	1	.5	.5	79.2
13.50	5	2.6	2.6	81.8
13.51	2	1.0	1.0	82.8
13.52	2	1.0	1.0	83.9
13.54	2	1.0	1.0	84.9
13.55	1	.5	.5	85.4
13.57	1	.5	.5	85.9
13.58	1	.5	.5	86.5
13.60	2	1.0	1.0	87.5
13.64	1	.5	.5	88.0
13.65	1	.5	.5	88.5
13.71	1	.5	.5	89.1
13.72	1	.5	.5	89.6
13.74	2	1.0	1.0	90.6
13.76	4	2.1	2.1	92.7
13.78	2	1.0	1.0	93.8
13.81	1	.5	.5	94.3
13.89	2	1.0	1.0	95.3
13.96	1	.5	.5	95.8
13.97	1	.5	.5	96.4
13.99	1	.5	.5	96.9
14.00	1	.5	.5	97.4
14.02	1	.5	.5	97.9
14.08	1	.5	.5	98.4
14.09	1	.5	.5	99.0
14.14	1	.5	.5	99.5
14.21	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT LEFT PRESENCE LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	13.054	Std Err	.043	Median	13.130
Mode	13.260	Std Dev	.606	Variance	.368
Range	3.390	Minimum	10.820	Maximum	14.210

VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
10.27	1	.5	.5	.5
10.55	1	.5	.5	1.0
10.62	1	.5	.5	1.6
10.67	1	.5	.5	2.1
10.86	1	.5	.5	2.6
10.89	1	.5	.5	3.1
11.05	1	.5	.5	3.7
11.12	1	.5	.5	4.2
11.22	1	.5	.5	4.7
11.25	1	.5	.5	5.2
11.30	1	.5	.5	5.8
11.31	1	.5	.5	6.3
11.36	1	.5	.5	6.8
11.39	1	.5	.5	7.3
11.40	1	.5	.5	7.9
11.43	1	.5	.5	8.4
11.44	1	.5	.5	8.9
11.49	1	.5	.5	9.4
11.59	2	1.0	1.0	10.5
11.60	3	1.6	1.6	12.0
11.61	1	.5	.5	12.6
11.62	1	.5	.5	13.1
11.63	1	.5	.5	13.6
11.70	2	1.0	1.0	14.7
11.71	1	.5	.5	15.2
11.72	2	1.0	1.0	16.2
11.76	3	1.6	1.6	17.8
11.79	3	1.6	1.6	19.4
11.86	1	.5	.5	19.9
11.88	1	.5	.5	20.4
11.96	1	.5	.5	20.9
11.97	1	.5	.5	21.5
12.05	1	.5	.5	22.0
12.10	3	1.6	1.6	23.6
12.12	2	1.0	1.0	24.6
12.16	1	.5	.5	25.1
12.17	1	.5	.5	25.7
12.20	1	.5	.5	26.2
12.22	1	.5	.5	26.7
12.27	1	.5	.5	27.2
12.28	2	1.0	1.0	28.3
12.29	1	.5	.5	28.8
12.38	1	.5	.5	29.3
12.41	1	.5	.5	29.8

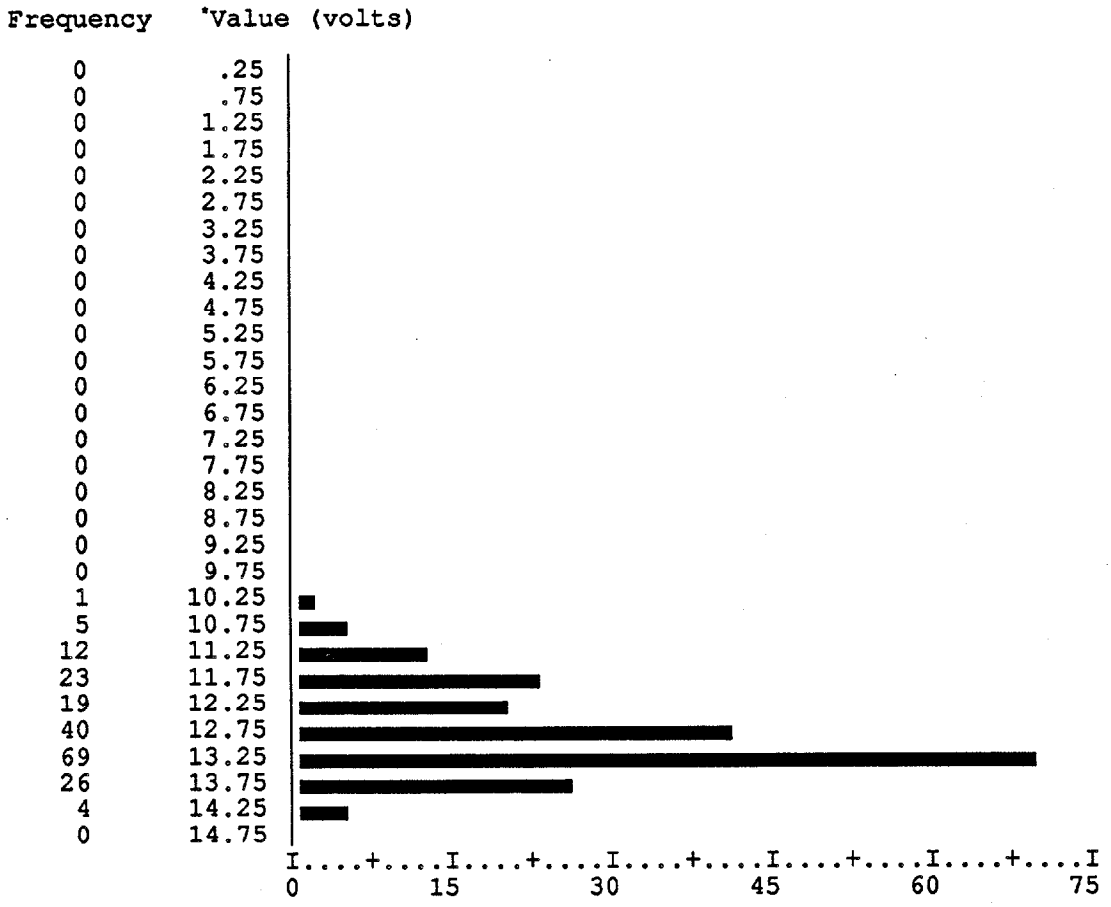
VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.43	1	.5	.5	30.4
12.44	1	.5	.5	30.9
12.50	2	1.0	1.0	31.9
12.51	1	.5	.5	32.5
12.54	1	.5	.5	33.0
12.55	1	.5	.5	33.5
12.59	2	1.0	1.0	34.6
12.60	1	.5	.5	35.1
12.61	1	.5	.5	35.6
12.62	1	.5	.5	36.1
12.63	1	.5	.5	36.6
12.65	2	1.0	1.0	37.7
12.66	2	1.0	1.0	38.7
12.67	2	1.0	1.0	39.8
12.68	2	1.0	1.0	40.8
12.71	1	.5	.5	41.4
12.75	2	1.0	1.0	42.4
12.78	1	.5	.5	42.9
12.79	1	.5	.5	43.5
12.80	1	.5	.5	44.0
12.82	1	.5	.5	44.5
12.85	1	.5	.5	45.0
12.86	2	1.0	1.0	46.1
12.87	1	.5	.5	46.6
12.92	1	.5	.5	47.1
12.93	1	.5	.5	47.6
12.95	1	.5	.5	48.2
12.96	2	1.0	1.0	49.2
12.97	1	.5	.5	49.7
12.98	1	.5	.5	50.3
12.99	2	1.0	1.0	51.3
13.00	1	.5	.5	51.8
13.01	2	1.0	1.0	52.9
13.02	1	.5	.5	53.4
13.03	3	1.6	1.6	55.0
13.04	2	1.0	1.0	56.0
13.05	4	2.1	2.1	58.1
13.06	3	1.6	1.6	59.7
13.07	2	1.0	1.0	60.7
13.08	2	1.0	1.0	61.8
13.10	2	1.0	1.0	62.8
13.11	1	.5	.5	63.4
13.12	1	.5	.5	63.9
13.13	3	1.6	1.6	65.4

VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.14	2	1.0	1.0	66.5
13.16	2	1.0	1.0	67.5
13.18	1	.5	.5	68.1
13.20	2	1.0	1.0	69.1
13.21	1	.5	.5	69.6
13.23	1	.5	.5	70.2
13.24	1	.5	.5	70.7
13.25	3	1.6	1.6	72.3
13.26	2	1.0	1.0	73.3
13.27	1	.5	.5	73.8
13.28	3	1.6	1.6	75.4
13.30	2	1.0	1.0	76.4
13.35	2	1.0	1.0	77.5
13.36	1	.5	.5	78.0
13.37	3	1.6	1.6	79.6
13.38	1	.5	.5	80.1
13.42	3	1.6	1.6	81.7
13.44	5	2.6	2.6	84.3
13.48	1	.5	.5	84.8
13.50	4	2.1	2.1	86.9
13.54	1	.5	.5	87.4
13.55	1	.5	.5	88.0
13.56	1	.5	.5	88.5
13.59	1	.5	.5	89.0
13.60	2	1.0	1.0	90.1
13.68	2	1.0	1.0	91.1
13.70	2	1.0	1.0	92.1
13.71	1	.5	.5	92.7
13.73	1	.5	.5	93.2
13.74	1	.5	.5	93.7
13.76	1	.5	.5	94.2
13.77	1	.5	.5	94.8
13.87	1	.5	.5	95.3
13.89	2	1.0	1.0	96.3
13.90	1	.5	.5	96.9
13.94	1	.5	.5	97.4
13.99	1	.5	.5	97.9
14.01	1	.5	.5	98.4
14.05	1	.5	.5	99.0
14.13	1	.5	.5	99.5
14.18	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	12.739	Std Err	.057	Median	12.990
Mode	13.440	Std Dev	.810	Variance	.657
Range	3.910	Minimum	10.270	Maximum	14.180

VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
10.76	1	.5	.5	.5
11.05	1	.5	.5	1.0
11.30	1	.5	.5	1.6
11.36	1	.5	.5	2.1
11.49	1	.5	.5	2.6
11.60	1	.5	.5	3.1
11.72	1	.5	.5	3.7
11.74	1	.5	.5	4.2
11.75	1	.5	.5	4.7
11.76	1	.5	.5	5.2
11.80	1	.5	.5	5.8
11.83	1	.5	.5	6.3
11.92	1	.5	.5	6.8
12.01	1	.5	.5	7.3
12.07	1	.5	.5	7.9
12.10	1	.5	.5	8.4
12.20	1	.5	.5	8.9
12.21	1	.5	.5	9.4
12.22	4	2.1	2.1	11.5
12.26	1	.5	.5	12,0
12.43	1	.5	.5	12.6
12.44	2	1.0	1.0	13.6
12.50	2	1.0	1.0	14.7
12.53	1	.5	.5	15.2
12.54	1	.5	.5	15.7
12.55	1	.5	.5	16.2
12.58	1	.5	.5	16.8
12.60	2	1.0	1.0	17.8
12.61	1	.5	.5	18.3
12.62	1	.5	.5	18.8
12.64	1	.5	.5	19.4
12.65	1	.5	.5	19.9
12.66	3	1.6	1.6	21.5
12.67	2	1.0	1.0	22.5
12.68	2	1.0	1.0	23.6
12.70	2	1.0	1.0	24.6
12.71	1	.5	.5	25.1
12.72	1	.5	.5	25.7
12.75	3	1.6	1.6	27.2
12.79	1	.5	.5	27.7
12.80	1	.5	.5	28.3
12.81	2	1.0	1.0	29.3
12.82	2	1.0	1.0	30.4
12.85	1	.5	.5	30.9

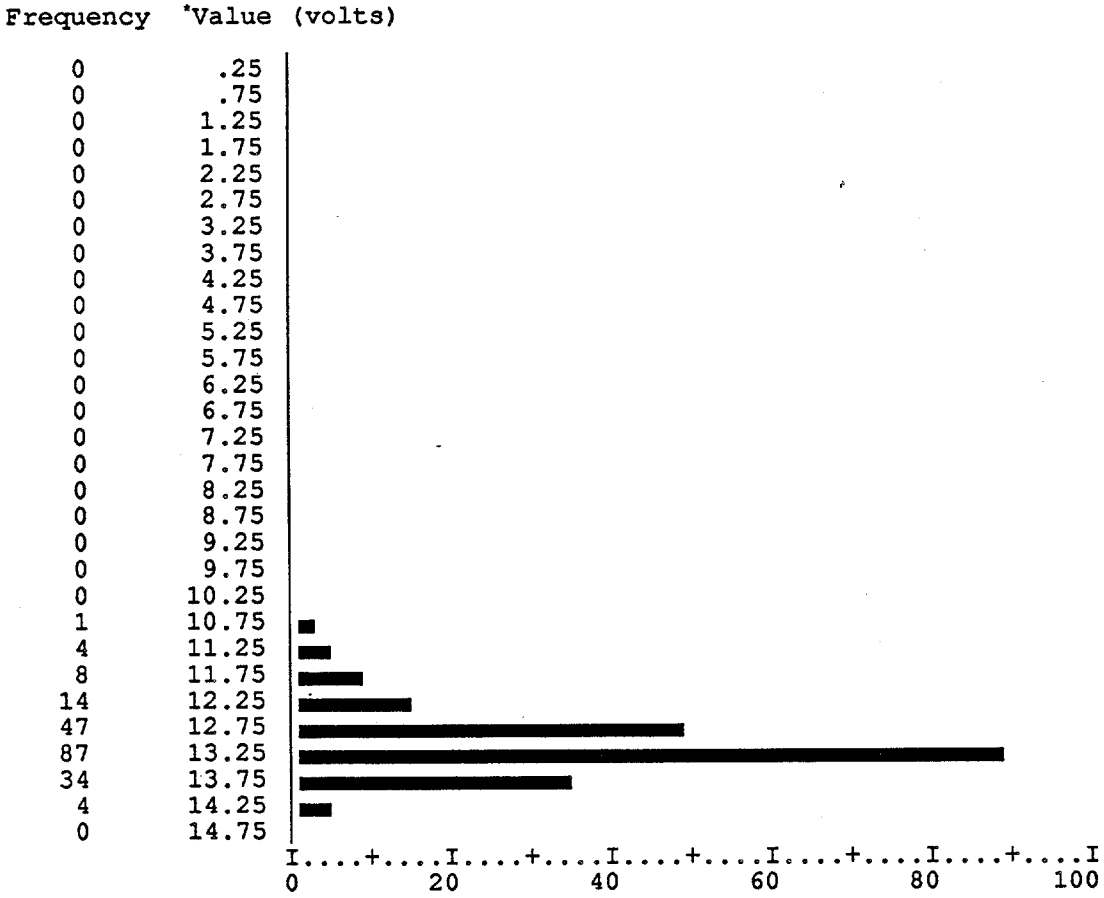
VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.86	1	.5	.5	31.4
12.87	1	.5	.5	31.9
12.88	1	.5	.5	32.5
12.90	3	1.6	1.6	34.0
12.91	1	.5	.5	34.6
12.93	1	.5	.5	35.1
12.95	3	1.6	1.6	36.6
12.96	2	1.0	1.0	37.7
12.98	1	.5	.5	38.2
13.01	2	1.0	1.0	39.3
13.02	2	1.0	1.0	40.3
13.03	3	1.6	1.6	41.9
13.04	4	2.1	2.1	44.0
13.05	4	2.1	2.1	46.1
13.06	2	1.0	1.0	47.1
13.08	1	.5	.5	47.6
13.09	2	1.0	1.0	48.7
13.10	7	3.6	3.7	52.4
13.11	2	1.0	1.0	53.4
13.13	1	.5	.5	53.9
13.14	3	1.6	1.6	55.5
13.15	6	3.1	3.1	58.6
13.16	1	.5	.5	59.2
13.18	2	1.0	1.0	60.2
13.19	2	1.0	1.0	61.3
13.21	1	.5	.5	61.8
13.22	1	.5	.5	62.3
13.24	2	1.0	1.0	63.4
13.25	1	.5	.5	63.9
13.26	1	.5	.5	64.4
13.27	2	1.0	1.0	65.4
13.28	3	1.6	1.6	67.0
13.30	4	2.1	2.1	69.1
13.31	2	1.0	1.0	70.2
13.32	3	1.6	1.6	71.7
13.34	1	.5	.5	72.3
13.39	1	.5	.5	72.8
13.40	2	1.0	1.0	73.8
13.41	1	.5	.5	74.3
13.42	2	1.0	1.0	75.4
13.44	3	1.6	1.6	77.0
13.45	3	1.6	1.6	78.5
13.46	3	1.6	1.6	80.1
13.47	1	.5	.5	80.6

VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.49	1	.5	.5	81.2
13.50	6	3.1	3.1	84.3
13.51	1	.5	.5	84.8
13.52	1	.5	.5	85.3
13.53	1	.5	.5	85.9
13.55	1	.5	.5	86.4
13.59	1	.5	.5	86.9
13.60	1	.5	.5	87.4
13.61	2	1.0	1.0	88.5
13.69	2	1.0	1.0	89.5
13.70	3	1.6	1.6	91.1
13.71	2	1.0	1.0	92.1
13.74	1	.5	.5	92.7
13.76	2	1.0	1.0	93.7
13.77	1	.5	.5	94.2
13.81	1	.5	.5	94.8
13.85	1	.5	.5	95.3
13.89	2	1.0	1.0	96.3
13.91	1	.5	.5	96.9
13.96	1	.5	.5	97.4
13.97	1	.5	.5	97.9
14.05	1	.5	.5	98.4
14.06	1	.5	.5	99.0
14.14	1	.5	.5	99.5
14.15	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT RIGHT PRESENCE LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	13.025	Std Err	.042	Median	13.100
Mode	13.100	Std Dev	.591	Variance	.350
Range	3.390	Minimum	10.760	Maximum	14.150

AMPERAGE READINGS AT LEFT TURN SIGNAL LAMP AT LOW IDLE

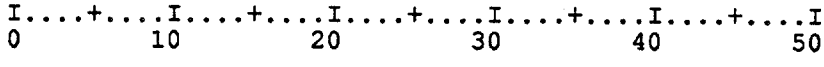
Value	Frequency	Percent	Valid Percent	Cum Percent
1.16	1	.5	.5	.5
1.20	1	.5	.5	1.0
1.29	1	.5	.5	1.6
1.68	1	.5	.5	2.1
1.72	1	.5	.5	2.6
1.76	1	.5	.5	3.1
1.80	3	1.6	1.6	4.7
1.84	1	.5	.5	5.2
1.88	4	2.1	2.1	7.3
1.90	1	.5	.5	7.8
1.92	3	1.6	1.6	9.4
1.95	1	.5	.5	9.9
1.96	5	2.6	2.6	12.5
1.98	1	.5	.5	13.0
2.00	7	3.6	3.6	16.7
2.01	9	4.7	4.7	21.4
2.02	2	1.0	1.0	22.4
2.03	1	.5	.5	22.9
2.04	9	4.7	4.7	27.6
2.05	6	3.1	3.1	30.7
2.06	2	1.0	1.0	31.8
2.08	11	5.7	5.7	37.5
2.09	1	.5	.5	38.0
2.10	6	3.1	3.1	41.1
2.11	2	1.0	1.0	42.2
2.12	10	5.2	5.2	47.4
2.14	1	.5	.5	47.9
2.15	1	.5	.5	48.4
2.16	20	10.4	10.4	58.9
2.20	16	8.3	8.3	67.2
2.23	2	1.0	1.0	68.2
2.24	15	7.8	7.8	76.0
2.28	14	7.3	7.3	83.3
2.29	2	1.0	1.0	84.4
2.30	1	.5	.5	84.9
2.32	11	5.7	5.7	90.6
2.35	1	.5	.5	91.1
2.36	5	2.6	2.6	93.8
2.39	1	.5	.5	94.3
2.40	5	2.6	2.6	96.9
2.44	1	.5	.5	97.4

AMPERAGE READINGS AT LEFT TURN SIGNAL LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
2.48	1	.5	.5	97.9
2.49	1	.5	.5	98.4
2.56	1	.5	.5	99.0
2.72	1	.5	.5	99.5
3.04	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT LEFT TURN SIG. LAMP AT LOW IDLE (continued)

Frequency	*Value (amps)
0	.05
0	.15
0	.25
0	.35
0	.45
0	.55
0	.65
0	.75
0	.85
0	.95
0	1.05
2	1.15
1	1.25
0	1.35
0	1.45
0	1.55
1	1.65
5	1.75
6	1.85
17	1.95
47	2.05
34	2.15
49	2.25
23	2.35
3	2.45
1	2.55
0	2.65
1	2.75
0	2.85
0	2.95



Frequency of Readings

* Values are presented at intervals of .10 amps

Mean	2.136	Std Err	.015	Median	2.160
Mode	2.160	Std Dev	.206	Variance	.042
Range	1.880	Minimum	1.160	Maximum	3.040

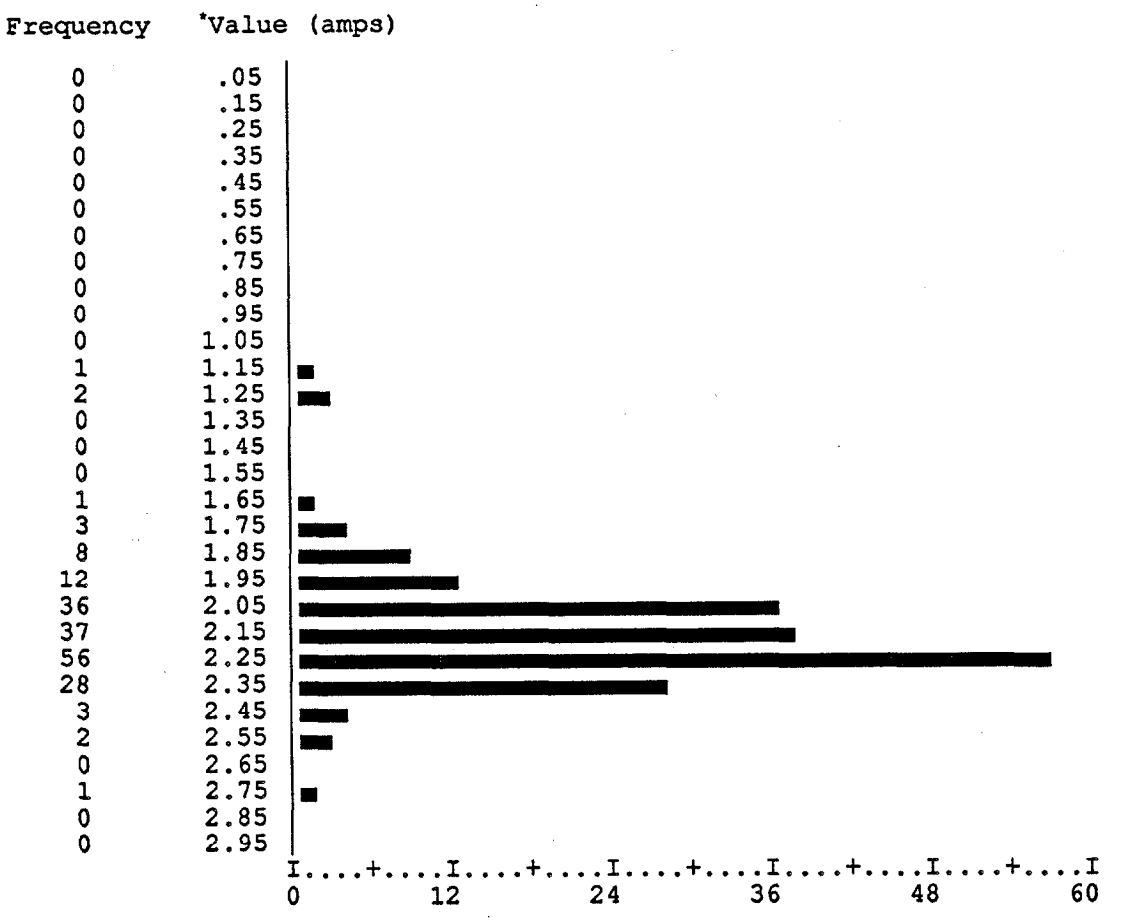
AMPERAGE READINGS AT LEFT TURN SIGNAL LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.20	1	.5	.5	.5
1.24	1	.5	.5	1.0
1.29	1	.5	.5	1.5
1.68	1	.5	.5	2.0
1.72	1	.5	.5	2.5
1.80	3	1.5	1.5	4.0
1.84	2	1.0	1.0	5.1
1.88	5	2.5	2.5	7.6
1.90	1	.5	.5	8.1
1.92	2	1.0	1.0	9.1
1.96	3	1.5	1.5	10.6
1.98	1	.5	.5	11.1
1.99	1	.5	.5	11.6
2.00	5	2.5	2.5	14.1
2.01	6	3.0	3.0	17.2
2.02	1	.5	.5	17.7
2.03	2	1.0	1.0	18.7
2.04	9	4.5	4.5	23.2
2.05	4	2.0	2.0	25.3
2.07	1	.5	.5	25.8
2.08	6	3.0	3.0	28.8
2.10	8	4.0	4.0	32.8
2.11	2	1.0	1.0	33.8
2.12	11	5.6	5.6	39.4
2.14	2	1.0	1.0	40.4
2.15	2	1.0	1.0	41.4
2.16	20	10.1	10.1	51.5
2.17	1	.5	.5	52.0
2.20	15	7.6	7.6	59.6
2.23	1	.5	.5	60.1
2.24	20	10.1	10.1	70.2
2.27	1	.5	.5	70.7
2.28	18	9.1	9.1	79.8
2.29	2	1.0	1.0	80.8
2.30	2	1.0	1.0	81.8
2.32	15	7.6	7.6	89.4
2.35	2	1.0	1.0	90.4
2.36	6	3.0	3.0	93.4
2.38	1	.5	.5	93.9
2.40	5	2.5	2.5	96.5
2.42	1	.5	.5	97.0
2.44	1	.5	.5	97.5
2.48	1	.5	.5	98.0

AMPERAGE READINGS AT LEFT TURN SIGNAL LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
2.55	1	.5	.5	98.5
2.60	1	.5	.5	99.0
2.72	1	.5	.5	99.5
3.04	1	.5	.5	100.0
TOTAL	198	100.0	100.0	

AMPERAGE READINGS AT LEFT TURN SIG. LAMP AT HIGH IDLE (continued)



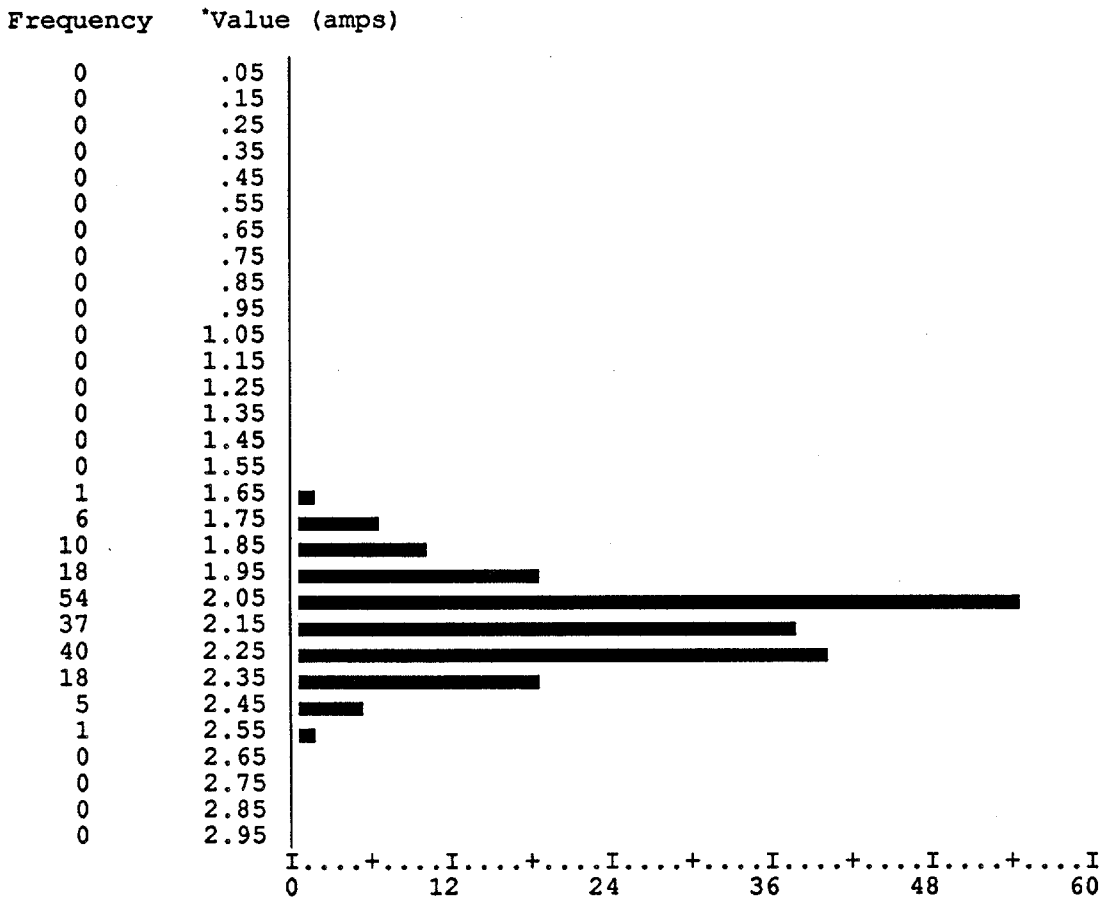
* Values are presented at intervals of .10 amps

Mean	2.160	Std Err	.015	Median	2.160
Mode	2.160	Std Dev	.204	Variance	.042
Range	1.840	Minimum	1.200	Maximum	3.040

AMPERAGE READINGS AT RIGHT TURN SIGNAL LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.68	1	.5	.5	.5
1.74	1	.5	.5	1.0
1.76	3	1.6	1.6	2.6
1.80	2	1.0	1.0	3.6
1.84	1	.5	.5	4.2
1.88	7	3.6	3.6	7.8
1.90	2	1.0	1.0	8.9
1.92	3	1.6	1.6	10.4
1.94	1	.5	.5	10.9
1.95	1	.5	.5	11.5
1.96	4	2.1	2.1	13.5
1.97	1	.5	.5	14.1
1.98	1	.5	.5	14.6
1.99	2	1.0	1.0	15.6
2.00	5	2.6	2.6	18.2
2.01	6	3.1	3.1	21.4
2.02	5	2.6	2.6	24.0
2.04	12	6.3	6.3	30.2
2.05	8	4.2	4.2	34.4
2.06	3	1.6	1.6	35.9
2.07	1	.5	.5	36.5
2.08	14	7.3	7.3	43.8
2.10	5	2.6	2.6	46.4
2.12	17	8.9	8.9	55.2
2.15	1	.5	.5	55.7
2.16	19	9.9	9.9	65.6
2.18	1	.5	.5	66.1
2.20	14	7.3	7.3	73.4
2.21	2	1.0	1.0	74.5
2.24	9	4.7	4.7	79.2
2.25	1	.5	.5	79.7
2.26	1	.5	.5	80.2
2.28	12	6.3	6.3	86.5
2.30	1	.5	.5	87.0
2.32	8	4.2	4.2	91.1
2.33	3	1.6	1.6	92.7
2.36	3	1.6	1.6	94.3
2.39	1	.5	.5	94.8
2.40	3	1.6	1.6	96.4
2.44	3	1.6	1.6	97.9
2.48	1	.5	.5	98.4
2.49	1	.5	.5	99.0
2.52	1	.5	.5	99.5
3.04	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT RIGHT TURN SIG. LAMP AT LOW IDLE (continued)



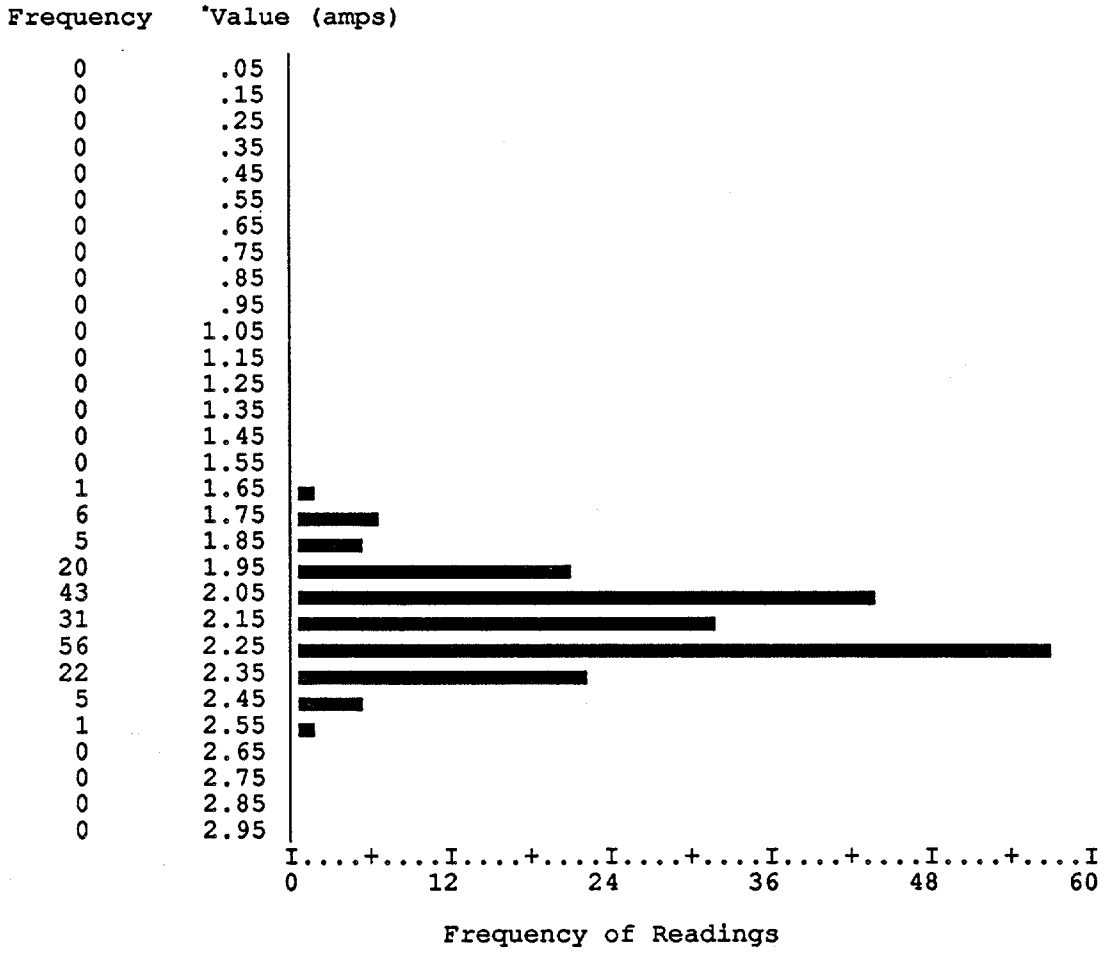
* Values are presented at intervals of .10 amps

Mean	2.127	Std Err	.012	Median	2.120
Mode	2.160	Std Dev	.168	Variance	.028
Range	1.360	Minimum	1.680	Maximum	3.040

AMPERAGE READINGS AT RIGHT TURN SIGNAL LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
1.68	1	.5	.5	.5
1.74	1	.5	.5	1.0
1.76	3	1.6	1.6	2.6
1.80	2	1.0	1.0	3.6
1.88	3	1.6	1.6	5.2
1.90	2	1.0	1.0	6.3
1.92	3	1.6	1.6	7.8
1.93	1	.5	.5	8.3
1.96	3	1.6	1.6	9.9
1.98	1	.5	.5	10.4
1.99	2	1.0	1.0	11.5
2.00	10	5.2	5.2	16.7
2.01	3	1.6	1.6	18.2
2.02	5	2.6	2.6	20.8
2.04	9	4.7	4.7	25.5
2.05	6	3.1	3.1	28.6
2.06	1	.5	.5	29.2
2.07	2	1.0	1.0	30.2
2.08	9	4.7	4.7	34.9
2.10	8	4.2	4.2	39.1
2.12	17	8.9	8.9	47.9
2.15	1	.5	.5	48.4
2.16	14	7.3	7.3	55.7
2.20	20	10.4	10.4	66.1
2.21	2	1.0	1.0	67.2
2.24	13	6.8	6.8	74.0
2.25	2	1.0	1.0	75.0
2.26	1	.5	.5	75.5
2.27	1	.5	.5	76.0
2.28	15	7.8	7.8	83.9
2.30	2	1.0	1.0	84.9
2.32	11	5.7	5.7	90.6
2.33	3	1.6	1.6	92.2
2.36	4	2.1	2.1	94.3
2.40	4	2.1	2.1	96.4
2.44	2	1.0	1.0	97.4
2.48	2	1.0	1.0	98.4
2.49	1	.5	.5	99.0
2.60	1	.5	.5	99.5
3.04	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

AMPERAGE READINGS AT RIGHT TURN SIGNAL LAMP HIGH IDLE (continued)



* Values are presented at intervals of .10 amps

Mean	2.152	Std Err	.012	Median	2.160
Mode	2.200	Std Dev	.167	Variance	.028
Range	1.360	Minimum	1.680	Maximum	3.040

VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
9.28	1	.5	.5	.5
9.44	2	1.0	1.0	1.6
9.45	1	.5	.5	2.1
9.60	1	.5	.5	2.6
9.72	1	.5	.5	3.1
9.76	1	.5	.5	3.6
9.92	1	.5	.5	4.2
10.00	1	.5	.5	4.7
10.08	2	1.0	1.0	5.7
10.10	1	.5	.5	6.3
10.12	2	1.0	1.0	7.3
10.20	3	1.6	1.6	8.9
10.24	1	.5	.5	9.4
10.28	1	.5	.5	9.9
10.40	2	1.0	1.0	10.9
10.44	2	1.0	1.0	12.0
10.48	2	1.0	1.0	13.0
10.60	2	1.0	1.0	14.1
10.64	1	.5	.5	14.6
10.68	2	1.0	1.0	15.6
10.76	2	1.0	1.0	16.7
10.88	3	1.6	1.6	18.2
10.90	2	1.0	1.0	19.3
10.96	2	1.0	1.0	20.3
11.00	3	1.6	1.6	21.9
11.04	1	.5	.5	22.4
11.05	1	.5	.5	22.9
11.08	4	2.1	2.1	25.0
11.10	1	.5	.5	25.5
11.12	2	1.0	1.0	26.6
11.16	2	1.0	1.0	27.6
11.20	2	1.0	1.0	28.6
11.24	1	.5	.5	29.2
11.36	2	1.0	1.0	30.2
11.44	4	2.1	2.1	32.3
11.45	1	.5	.5	32.8
11.48	3	1.6	1.6	34.4
11.50	1	.5	.5	34.9
11.52	1	.5	.5	35.4
11.56	1	.5	.5	35.9
11.60	3	1.6	1.6	37.5
11.64	3	1.6	1.6	39.1
11.72	3	1.6	1.6	40.6
11.76	4	2.1	2.1	42.7

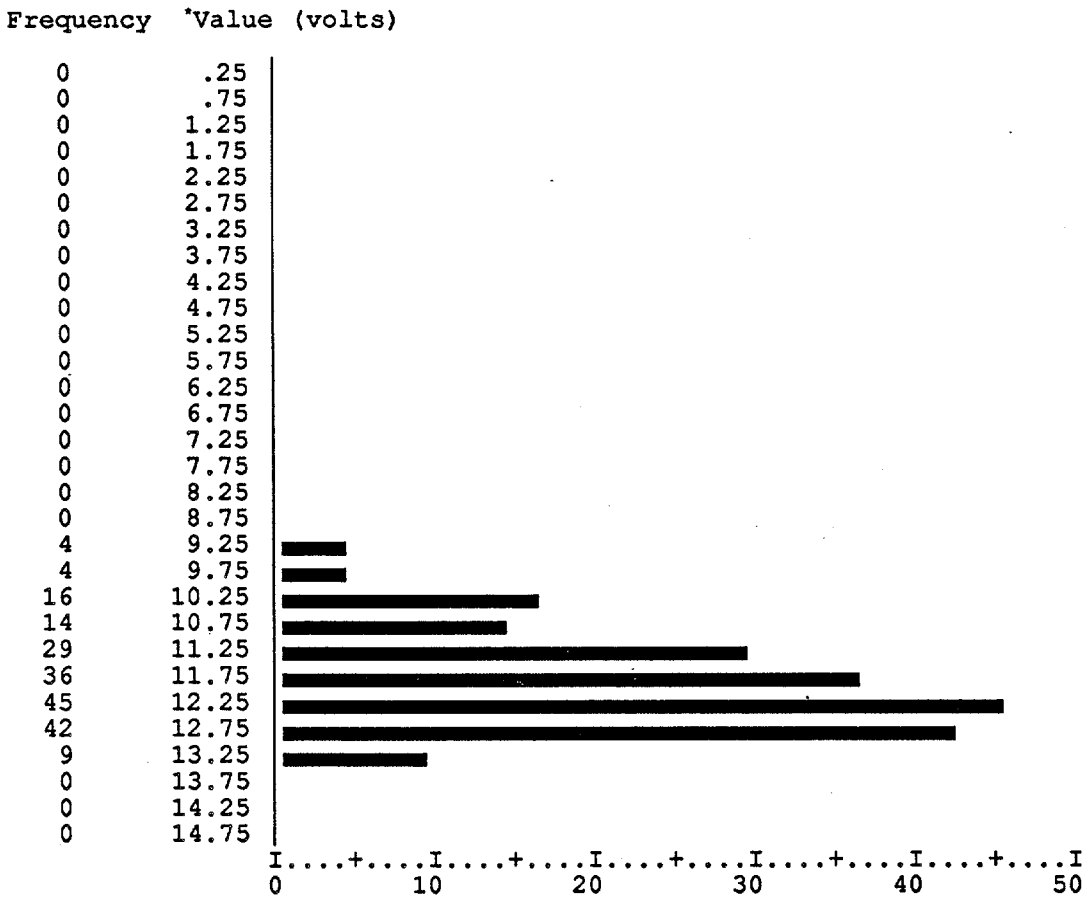
VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
11.78	1	.5	.5	43.2
11.80	5	2.6	2.6	45.8
11.82	1	.5	.5	46.4
11.84	5	2.6	2.6	49.0
11.88	1	.5	.5	49.5
11.90	2	1.0	1.0	50.5
11.92	1	.5	.5	51.0
11.95	1	.5	.5	51.6
11.96	1	.5	.5	52.1
11.99	1	.5	.5	52.6
12.00	1	.5	.5	53.1
12.01	1	.5	.5	53.6
12.04	3	1.6	1.6	55.2
12.07	1	.5	.5	55.7
12.08	2	1.0	1.0	56.8
12.10	1	.5	.5	57.3
12.12	3	1.6	1.6	58.9
12.13	1	.5	.5	59.4
12.16	5	2.6	2.6	62.0
12.20	3	1.6	1.6	63.5
12.24	2	1.0	1.0	64.6
12.29	1	.5	.5	65.1
12.30	1	.5	.5	65.6
12.32	5	2.6	2.6	68.2
12.36	1	.5	.5	68.8
12.40	3	1.6	1.6	70.3
12.42	1	.5	.5	70.8
12.44	3	1.6	1.6	72.4
12.48	4	2.1	2.1	74.5
12.50	3	1.6	1.6	76.0
12.56	3	1.6	1.6	77.6
12.58	1	.5	.5	78.1
12.60	1	.5	.5	78.6
12.62	1	.5	.5	79.2
12.64	3	1.6	1.6	80.7
12.72	4	2.1	2.1	82.8
12.75	1	.5	.5	83.3
12.76	4	2.1	2.1	85.4
12.80	5	2.6	2.6	88.0
12.84	6	3.1	3.1	91.1
12.85	1	.5	.5	91.7
12.88	2	1.0	1.0	92.7
12.96	3	1.6	1.6	94.3
12.98	2	1.0	1.0	95.3

VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.00	1	.5	.5	95.8
13.04	1	.5	.5	96.4
13.13	1	.5	.5	96.9
13.16	2	1.0	1.0	97.9
13.24	2	1.0	1.0	99.0
13.28	1	.5	.5	99.5
13.36	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	11.790	Std Err	.066	Median	11.920
Mode	12.320	Std Dev	.927	Variance	.859
Range	4.080	Minimum	9.280	Maximum	13.360

VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
9.96	1	.5	.5	.5
10.02	1	.5	.5	1.0
10.08	1	.5	.5	1.6
10.16	1	.5	.5	2.1
10.48	1	.5	.5	2.6
10.64	1	.5	.5	3.1
10.72	1	.5	.5	3.6
10.80	1	.5	.5	4.2
10.90	1	.5	.5	4.7
10.92	1	.5	.5	5.2
11.00	1	.5	.5	5.7
11.04	1	.5	.5	6.3
11.08	1	.5	.5	6.8
11.12	2	1.0	1.0	7.8
11.16	4	2.1	2.1	9.9
11.20	2	1.0	1.0	10.9
11.24	2	1.0	1.0	12.0
11.28	1	.5	.5	12.5
11.36	2	1.0	1.0	13.5
11.40	2	1.0	1.0	14.6
11.44	2	1.0	1.0	15.6
11.46	1	.5	.5	16.1
11.48	1	.5	.5	16.7
11.50	1	.5	.5	17.2
11.52	3	1.6	1.6	18.8
11.56	1	.5	.5	19.3
11.60	2	1.0	1.0	20.3
11.64	3	1.6	1.6	21.9
11.68	2	1.0	1.0	22.9
11.72	2	1.0	1.0	24.0
11.76	3	1.6	1.6	25.5
11.78	1	.5	.5	26.0
11.79	1	.5	.5	26.6
11.80	1	.5	.5	27.1
11.84	5	2.6	2.6	29.7
11.88	1	.5	.5	30.2
11.90	2	1.0	1.0	31.3
11.92	1	.5	.5	31.8
11.95	2	1.0	1.0	32.8
11.96	3	1.6	1.6	34.4
11.99	1	.5	.5	34.9
12.00	6	3.1	3.1	38.0
12.01	1	.5	.5	38.5
12.02	1	.5	.5	39.1

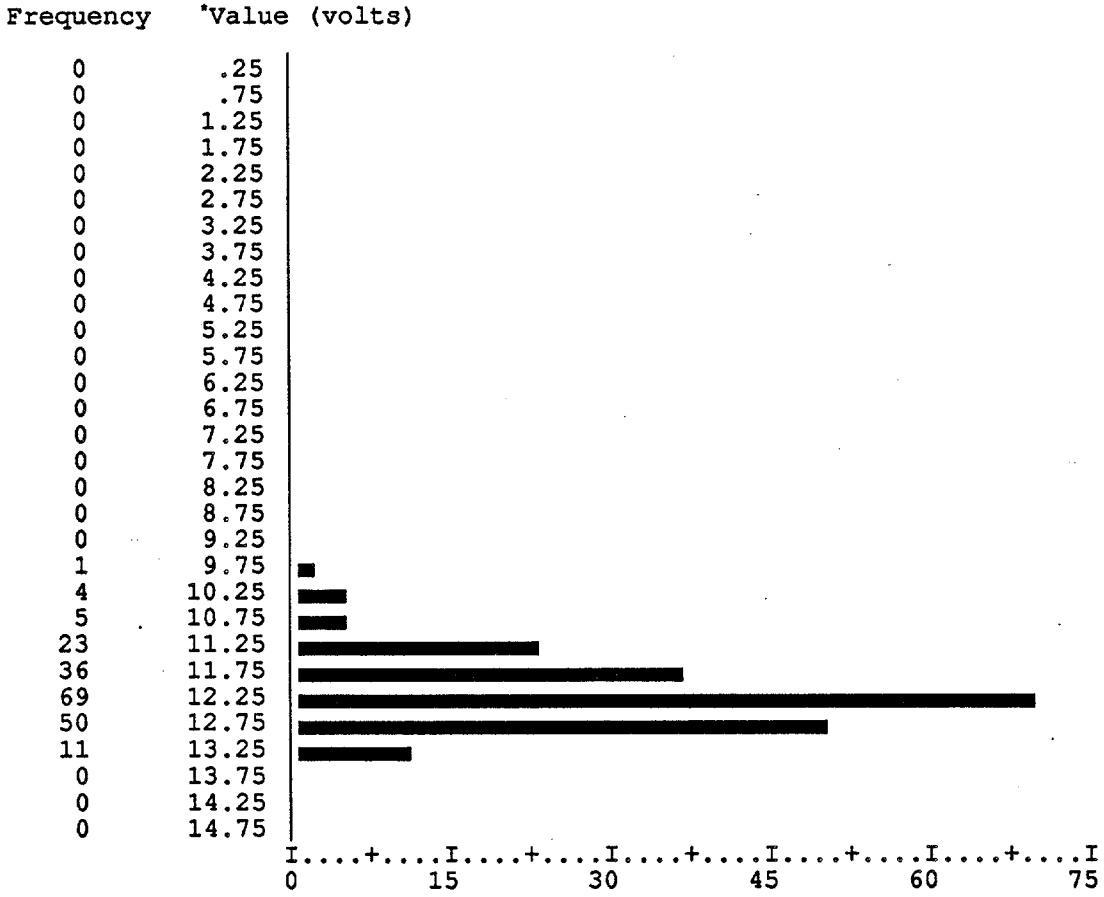
VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.04	3	1.6	1.6	40.6
12.08	2	1.0	1.0	41.7
12.10	4	2.1	2.1	43.8
12.11	1	.5	.5	44.3
12.12	3	1.6	1.6	45.8
12.14	1	.5	.5	46.4
12.15	1	.5	.5	46.9
12.16	8	4.2	4.2	51.0
12.22	1	.5	.5	51.6
12.24	4	2.1	2.1	53.6
12.28	1	.5	.5	54.2
12.29	1	.5	.5	54.7
12.32	2	1.0	1.0	55.7
12.33	1	.5	.5	56.3
12.36	8	4.2	4.2	60.4
12.38	1	.5	.5	60.9
12.40	6	3.1	3.1	64.1
12.44	2	1.0	1.0	65.1
12.45	1	.5	.5	65.6
12.48	8	4.2	4.2	69.8
12.50	4	2.1	2.1	71.9
12.52	2	1.0	1.0	72.9
12.55	1	.5	.5	73.4
12.56	3	1.6	1.6	75.0
12.58	1	.5	.5	75.5
12.60	2	1.0	1.0	76.6
12.62	1	.5	.5	77.1
12.64	4	2.1	2.1	79.2
12.70	1	.5	.5	79.7
12.72	5	2.6	2.6	82.3
12.75	1	.5	.5	82.8
12.76	5	2.6	2.6	85.4
12.80	4	2.1	2.1	87.5
12.84	6	3.1	3.1	90.6
12.85	1	.5	.5	91.1
12.88	1	.5	.5	91.7
12.92	1	.5	.5	92.2
12.95	1	.5	.5	92.7
12.96	2	1.0	1.0	93.8
12.98	1	.5	.5	94.3
13.00	2	1.0	1.0	95.3
13.04	1	.5	.5	95.8
13.05	1	.5	.5	96.4
13.13	1	.5	.5	96.9

VOLTAGE READINGS AT LEFT TURN SIGNAL LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.16	2	1.0	1.0	97.9
13.24	2	1.0	1.0	99.0
13.32	1	.5	.5	99.5
13.36	1	.5	.5	100.0
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT LEFT TURN SIG. LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	12.125	Std Err	.046	Median	12.220
Mode	12.360	Std Dev	.655	Variance	.429
Range	3.400	Minimum	9.960	Maximum	13.360

VOLTAGE READINGS AT RIGHT TURN SIGNAL LAMP AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
9.32	1	.5	.5	.5
9.45	2	1.0	1.0	1.6
9.50	1	.5	.5	2.1
9.60	1	.5	.5	2.6
9.80	1	.5	.5	3.1
9.88	2	1.0	1.0	4.2
9.92	1	.5	.5	4.7
9.96	1	.5	.5	5.2
9.98	1	.5	.5	5.8
10.04	1	.5	.5	6.3
10.16	2	1.0	1.0	7.3
10.30	2	1.0	1.0	8.4
10.32	2	1.0	1.0	9.4
10.40	1	.5	.5	9.9
10.48	2	1.0	1.0	11.0
10.50	1	.5	.5	11.5
10.52	1	.5	.5	12.0
10.60	3	1.6	1.6	13.6
10.64	1	.5	.5	14.1
10.68	1	.5	.5	14.7
10.72	1	.5	.5	15.2
10.80	2	1.0	1.0	16.2
10.84	3	1.6	1.6	17.8
10.90	1	.5	.5	18.3
10.92	1	.5	.5	18.8
10.96	3	1.6	1.6	20.4
11.00	4	2.1	2.1	22.5
11.04	2	1.0	1.0	23.6
11.05	1	.5	.5	24.1
11.08	2	1.0	1.0	25.1
11.10	1	.5	.5	25.7
11.12	1	.5	.5	26.2
11.16	2	1.0	1.0	27.2
11.20	1	.5	.5	27.7
11.28	1	.5	.5	28.3
11.36	1	.5	.5	28.8
11.40	1	.5	.5	29.3
11.44	1	.5	.5	29.8
11.48	2	1.0	1.0	30.9
11.50	2	1.0	1.0	31.9
11.52	1	.5	.5	32.5
11.56	1	.5	.5	33.0
11.60	3	1.6	1.6	34.6
11.64	3	1.6	1.6	36.1

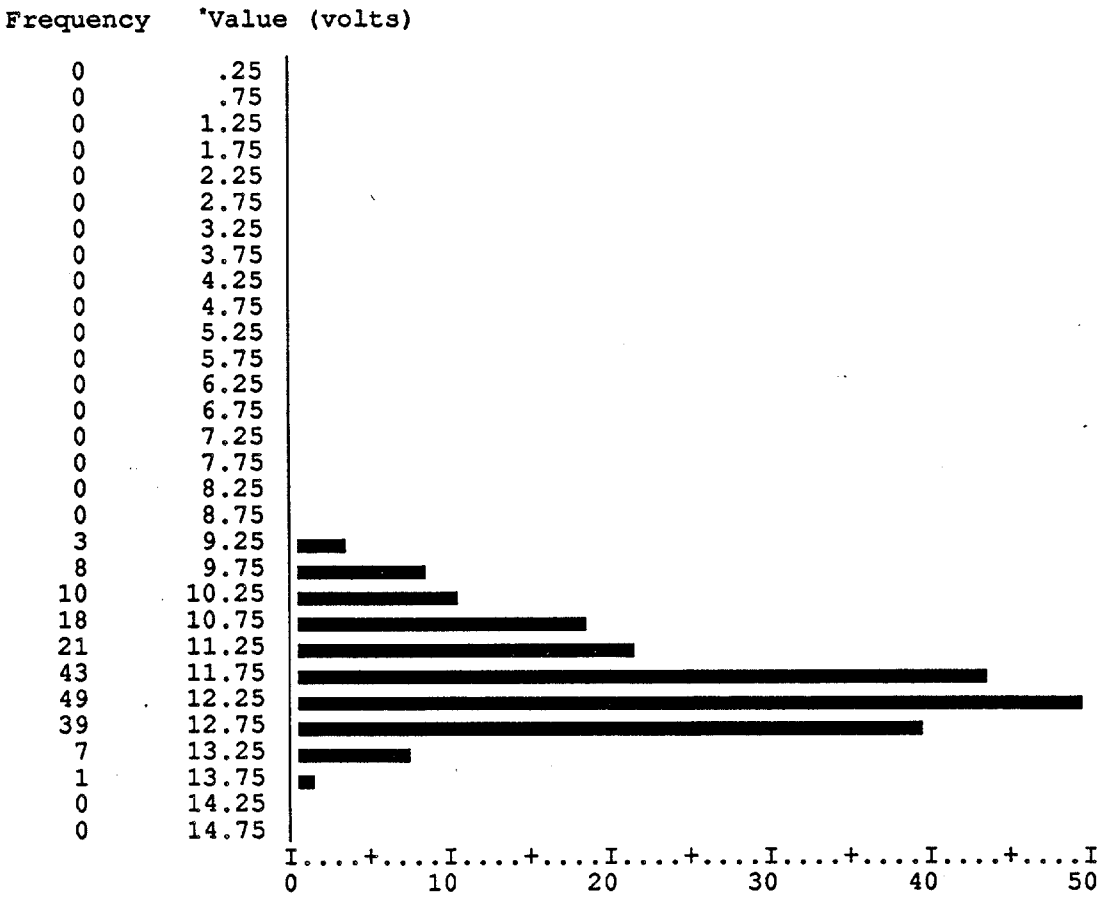
VOLTAGE READINGS AT RIGHT TURN SIGNAL LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
11.68	1	.5	.5	36.6
11.72	3	1.6	1.6	38.2
11.76	2	1.0	1.0	39.3
11.80	5	2.6	2.6	41.9
11.81	2	1.0	1.0	42.9
11.84	3	1.6	1.6	44.5
11.85	1	.5	.5	45.0
11.87	1	.5	.5	45.5
11.88	3	1.6	1.6	47.1
11.89	1	.5	.5	47.6
11.90	1	.5	.5	48.2
11.92	4	2.1	2.1	50.3
11.95	2	1.0	1.0	51.3
11.96	2	1.0	1.0	52.4
11.98	1	.5	.5	52.9
12.00	2	1.0	1.0	53.9
12.04	3	1.6	1.6	55.5
12.05	2	1.0	1.0	56.5
12.08	2	1.0	1.0	57.6
12.10	2	1.0	1.0	58.6
12.12	4	2.1	2.1	60.7
12.15	2	1.0	1.0	61.8
12.16	2	1.0	1.0	62.8
12.20	2	1.0	1.0	63.9
12.24	1	.5	.5	64.4
12.28	3	1.6	1.6	66.0
12.30	3	1.6	1.6	67.5
12.32	2	1.0	1.0	68.6
12.35	1	.5	.5	69.1
12.36	2	1.0	1.0	70.2
12.40	8	4.2	4.2	74.3
12.44	2	1.0	1.0	75.4
12.45	2	1.0	1.0	76.4
12.48	1	.5	.5	77.0
12.50	1	.5	.5	77.5
12.56	2	1.0	1.0	78.5
12.60	5	2.6	2.6	81.2
12.61	1	.5	.5	81.7
12.64	2	1.0	1.0	82.7
12.68	3	1.6	1.6	84.3
12.72	1	.5	.5	84.8
12.73	1	.5	.5	85.3
12.76	2	1.0	1.0	86.4
12.80	6	3.1	3.1	89.5

VOLTAGE READINGS AT RIGHT TURN SIGNAL LAMP AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.81	1	.5	.5	90.1
12.84	2	1.0	1.0	91.1
12.88	5	2.6	2.6	93.7
12.89	1	.5	.5	94.2
12.92	3	1.6	1.6	95.8
12.98	1	.5	.5	96.3
13.00	1	.5	.5	96.9
13.08	2	1.0	1.0	97.9
13.16	1	.5	.5	98.4
13.24	2	1.0	1.0	99.5
13.82	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT RIGHT TURN SIG. LAMP AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	11.800	Std Err	.065	Median	11.950
Mode	12.400	Std Dev	.911	Variance	.830
Range	4.500	Minimum	9.320	Maximum	13.820

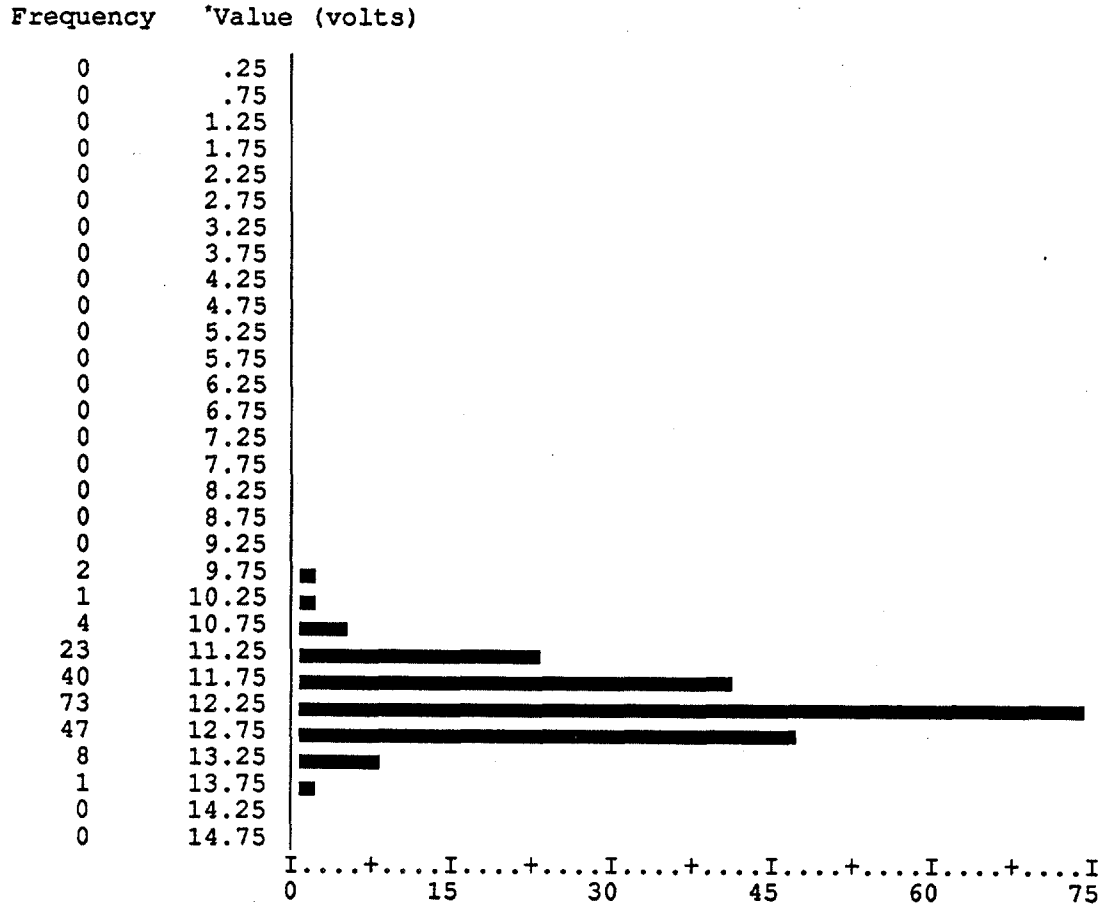
VOLTAGE READINGS AT RIGHT TURN SIGNAL LAMP AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
9.96	1	.5	.5	.5
9.98	1	.5	.5	1.0
10.20	1	.5	.5	1.6
10.60	1	.5	.5	2.1
10.72	1	.5	.5	2.6
10.76	1	.5	.5	3.1
10.80	1	.5	.5	3.7
11.00	3	1.6	1.6	5.2
11.04	1	.5	.5	5.8
11.05	1	.5	.5	6.3
11.08	1	.5	.5	6.8
11.09	1	.5	.5	7.3
11.20	1	.5	.5	7.9
11.22	1	.5	.5	8.4
11.24	3	1.6	1.6	9.9
11.28	4	2.1	2.1	12.0
11.30	1	.5	.5	12.6
11.35	1	.5	.5	13.1
11.36	1	.5	.5	13.6
11.40	1	.5	.5	14.1
11.44	1	.5	.5	14.7
11.48	2	1.0	1.0	15.7
11.52	1	.5	.5	16.2
11.55	1	.5	.5	16.8
11.56	1	.5	.5	17.3
11.60	3	1.6	1.6	18.8
11.64	3	1.6	1.6	20.4
11.66	1	.5	.5	20.9
11.68	4	2.1	2.1	23.0
11.72	3	1.6	1.6	24.6
11.76	1	.5	.5	25.1
11.80	2	1.0	1.0	26.2
11.84	5	2.6	2.6	28.8
11.88	3	1.6	1.6	30.4
11.90	1	.5	.5	30.9
11.92	2	1.0	1.0	31.9
11.95	3	1.6	1.6	33.5
11.96	5	2.6	2.6	36.1
12.00	1	.5	.5	36.6
12.04	4	2.1	2.1	38.7
12.05	2	1.0	1.0	39.8
12.08	3	1.6	1.6	41.4
12.10	4	2.1	2.1	43.5
12.12	5	2.6	2.6	46.1

VOLTAGE READINGS AT RIGHT TURN SIGNAL LAMP AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
12.16	4	2.1	2.1	48.2
12.20	5	2.6	2.6	50.8
12.24	2	1.0	1.0	51.8
12.25	1	.5	.5	52.4
12.28	4	2.1	2.1	54.5
12.30	2	1.0	1.0	55.5
12.32	4	2.1	2.1	57.6
12.35	2	1.0	1.0	58.6
12.36	3	1.6	1.6	60.2
12.38	2	1.0	1.0	61.3
12.40	13	6.8	6.8	68.1
12.44	3	1.6	1.6	69.6
12.45	1	.5	.5	70.2
12.48	4	2.1	2.1	72.3
12.50	3	1.6	1.6	73.8
12.52	1	.5	.5	74.3
12.56	1	.5	.5	74.9
12.60	6	3.1	3.1	78.0
12.64	3	1.6	1.6	79.6
12.66	1	.5	.5	80.1
12.68	2	1.0	1.0	81.2
12.69	1	.5	.5	81.7
12.70	1	.5	.5	82.2
12.72	4	2.1	2.1	84.3
12.73	1	.5	.5	84.8
12.76	2	1.0	1.0	85.9
12.80	6	3.1	3.1	89.0
12.81	1	.5	.5	89.5
12.84	1	.5	.5	90.1
12.85	1	.5	.5	90.6
12.88	6	3.1	3.1	93.7
12.92	1	.5	.5	94.2
12.95	1	.5	.5	94.8
12.96	2	1.0	1.0	95.8
13.01	1	.5	.5	96.3
13.04	1	.5	.5	96.9
13.08	2	1.0	1.0	97.9
13.16	1	.5	.5	98.4
13.20	1	.5	.5	99.0
13.28	1	.5	.5	99.5
13.82	1	.5	.5	100.0
.	1	.5	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT RIGHT TURN SIG. LAMP AT HIGH IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	12.139	Std Err	.044	Median	12.240
Mode	12.400	Std Dev	.625	Variance	.390
Range	3.860	Minimum	9.960	Maximum	13.820

VOLTAGE READINGS AT BATTERY AT LOW IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
11.10	1	.5	.5	.5
11.64	1	.5	.5	1.1
11.76	1	.5	.5	1.6
11.88	2	1.0	1.1	2.6
11.96	1	.5	.5	3.2
12.18	1	.5	.5	3.7
12.21	1	.5	.5	4.2
12.24	2	1.0	1.1	5.3
12.32	1	.5	.5	5.8
12.35	1	.5	.5	6.3
12.38	1	.5	.5	6.8
12.40	1	.5	.5	7.4
12.41	1	.5	.5	7.9
12.44	1	.5	.5	8.4
12.46	1	.5	.5	8.9
12.50	1	.5	.5	9.5
12.56	1	.5	.5	10.0
12.57	1	.5	.5	10.5
12.64	1	.5	.5	11.1
12.66	1	.5	.5	11.6
12.68	1	.5	.5	12.1
12.73	1	.5	.5	12.6
12.74	1	.5	.5	13.2
12.75	1	.5	.5	13.7
12.77	1	.5	.5	14.2
12.79	1	.5	.5	14.7
12.84	1	.5	.5	15.3
12.90	1	.5	.5	15.8
12.94	1	.5	.5	16.3
13.01	1	.5	.5	16.8
13.04	1	.5	.5	17.4
13.08	1	.5	.5	17.9
13.15	2	1.0	1.1	18.9
13.16	1	.5	.5	19.5
13.19	1	.5	.5	20.0
13.20	1	.5	.5	20.5
13.22	2	1.0	1.1	21.6
13.26	1	.5	.5	22.1
13.30	1	.5	.5	22.6
13.31	1	.5	.5	23.2
13.32	1	.5	.5	23.7
13.34	1	.5	.5	24.2
13.40	1	.5	.5	24.7
13.45	1	.5	.5	25.3

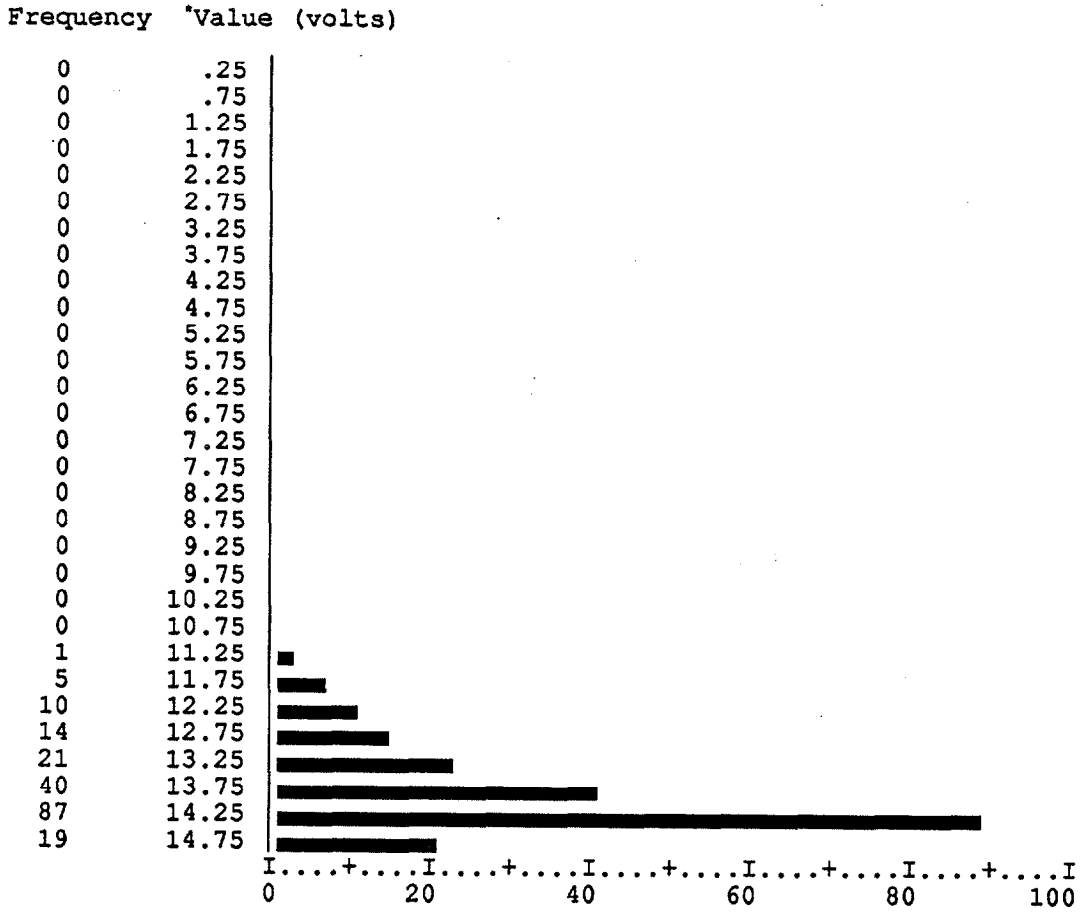
VOLTAGE READINGS AT BATTERY AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
13.46	1	.5	.5	25.8
13.47	1	.5	.5	26.3
13.48	1	.5	.5	26.8
13.50	4	2.1	2.1	28.9
13.56	1	.5	.5	29.5
13.59	1	.5	.5	30.0
13.61	2	1.0	1.1	31.1
13.62	1	.5	.5	31.6
13.64	1	.5	.5	32.1
13.65	1	.5	.5	32.6
13.66	1	.5	.5	33.2
13.67	1	.5	.5	33.7
13.70	2	1.0	1.1	34.7
13.72	1	.5	.5	35.3
13.78	1	.5	.5	35.8
13.80	1	.5	.5	36.3
13.83	1	.5	.5	36.8
13.86	2	1.0	1.1	37.9
13.87	3	1.6	1.6	39.5
13.88	2	1.0	1.1	40.5
13.90	1	.5	.5	41.1
13.91	1	.5	.5	41.6
13.92	1	.5	.5	42.1
13.95	1	.5	.5	42.6
13.96	1	.5	.5	43.2
13.98	3	1.6	1.6	44.7
13.99	4	2.1	2.1	46.8
14.00	3	1.6	1.6	48.4
14.01	2	1.0	1.1	49.5
14.02	1	.5	.5	50.0
14.03	1	.5	.5	50.5
14.04	2	1.0	1.1	51.6
14.05	1	.5	.5	52.1
14.06	1	.5	.5	52.6
14.07	4	2.1	2.1	54.7
14.08	2	1.0	1.1	55.8
14.11	2	1.0	1.1	56.8
14.12	1	.5	.5	57.4
14.13	2	1.0	1.1	58.4
14.15	2	1.0	1.1	59.5
14.16	6	3.1	3.2	62.6
14.17	1	.5	.5	63.2
14.18	2	1.0	1.1	64.2
14.19	3	1.6	1.6	65.8

VOLTAGE READINGS AT BATTERY AT LOW IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
14.20	1	.5	.5	66.3
14.21	1	.5	.5	66.8
14.22	2	1.0	1.1	67.9
14.23	1	.5	.5	68.4
14.24	4	2.1	2.1	70.5
14.25	1	.5	.5	71.1
14.26	1	.5	.5	71.6
14.27	1	.5	.5	72.1
14.28	1	.5	.5	72.6
14.29	4	2.1	2.1	74.7
14.30	1	.5	.5	75.3
14.31	1	.5	.5	75.8
14.32	4	2.1	2.1	77.9
14.33	1	.5	.5	78.4
14.34	1	.5	.5	78.9
14.36	2	1.0	1.1	80.0
14.37	4	2.1	2.1	82.1
14.39	1	.5	.5	82.6
14.40	1	.5	.5	83.2
14.41	1	.5	.5	83.7
14.42	2	1.0	1.1	84.7
14.44	2	1.0	1.1	85.8
14.45	1	.5	.5	86.3
14.46	2	1.0	1.1	87.4
14.48	3	1.6	1.6	88.9
14.49	3	1.6	1.6	90.5
14.50	2	1.0	1.1	91.6
14.54	2	1.0	1.1	92.6
14.55	1	.5	.5	93.2
14.56	1	.5	.5	93.7
14.59	3	1.6	1.6	95.3
14.62	1	.5	.5	95.8
14.63	1	.5	.5	96.3
14.65	2	1.0	1.1	97.4
14.66	1	.5	.5	97.9
14.69	1	.5	.5	98.4
14.70	1	.5	.5	98.9
14.80	2	1.0	1.1	100.0
.	2	1.0	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT BATTERY AT LOW IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	13.800	Std Err	.052	Median	14.030
Mode	14.160	Std Dev	.727	Variance	.529
Range	3.700	Minimum	11.100	Maximum	14.800

VOLTAGE READINGS AT BATTERY AT HIGH IDLE

Value	Frequency	Percent	Valid Percent	Cum Percent
12.12	1	.5	.5	.5
12.49	1	.5	.5	1.1
12.72	1	.5	.5	1.6
12.91	1	.5	.5	2.1
13.00	1	.5	.5	2.6
13.03	1	.5	.5	3.2
13.05	1	.5	.5	3.7
13.07	1	.5	.5	4.2
13.11	1	.5	.5	4.8
13.20	1	.5	.5	5.3
13.21	1	.5	.5	5.8
13.28	1	.5	.5	6.3
13.37	1	.5	.5	6.9
13.38	1	.5	.5	7.4
13.40	1	.5	.5	7.9
13.46	1	.5	.5	8.5
13.50	2	1.0	1.1	9.5
13.54	2	1.0	1.1	10.6
13.60	1	.5	.5	11.1
13.62	1	.5	.5	11.6
13.66	2	1.0	1.1	12.7
13.69	2	1.0	1.1	13.8
13.70	2	1.0	1.1	14.8
13.71	1	.5	.5	15.3
13.72	1	.5	.5	15.9
13.75	1	.5	.5	16.4
13.76	1	.5	.5	16.9
13.77	1	.5	.5	17.5
13.79	1	.5	.5	18.0
13.80	3	1.6	1.6	19.6
13.82	2	1.0	1.1	20.6
13.85	1	.5	.5	21.2
13.87	1	.5	.5	21.7
13.88	2	1.0	1.1	22.8
13.89	1	.5	.5	23.3
13.90	6	3.1	3.2	26.5
13.92	4	2.1	2.1	28.6
13.95	1	.5	.5	29.1
13.99	3	1.6	1.6	30.7
14.00	3	1.6	1.6	32.3
14.01	4	2.1	2.1	34.4
14.02	3	1.6	1.6	36.0
14.03	1	.5	.5	36.5
14.04	4	2.1	2.1	38.6

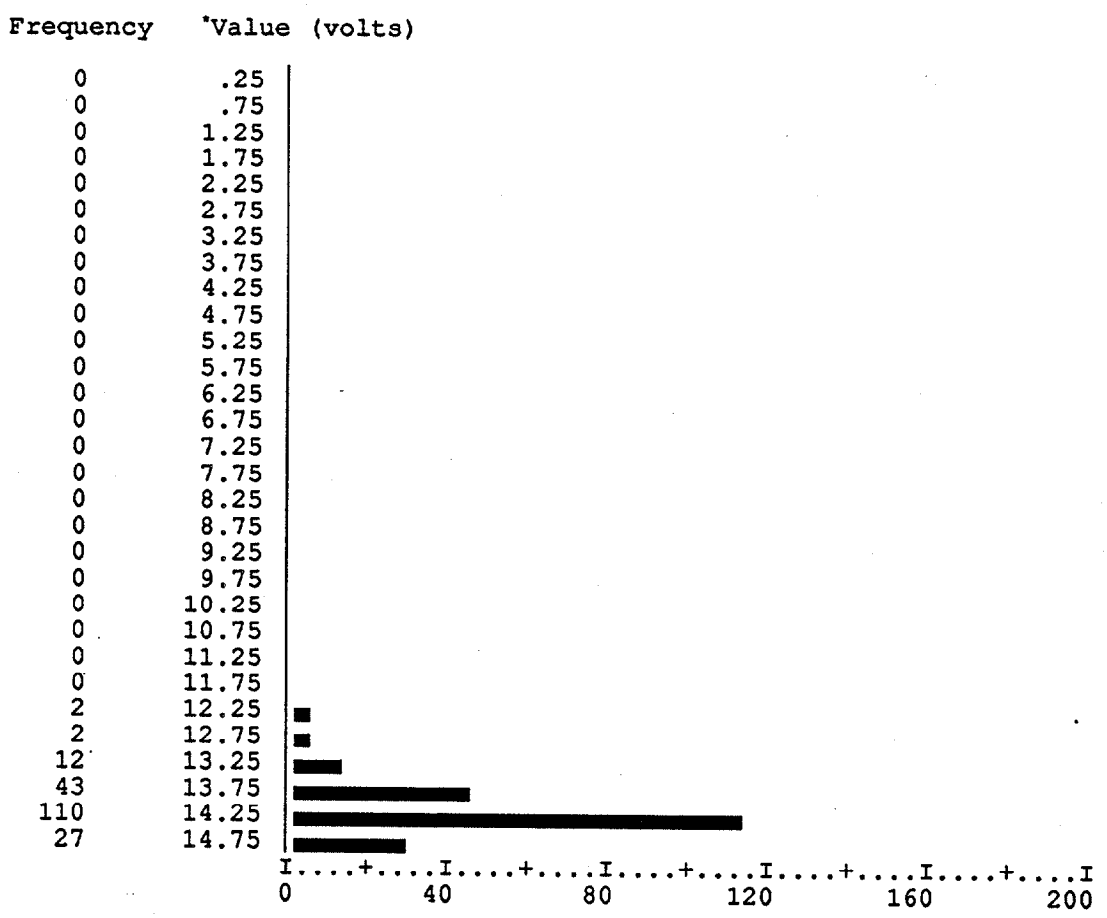
VOLTAGE READINGS AT BATTERY AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
14.05	1	.5	.5	39.2
14.06	3	1.6	1.6	40.7
14.07	1	.5	.5	41.3
14.08	3	1.6	1.6	42.9
14.09	5	2.6	2.6	45.5
14.10	2	1.0	1.1	46.6
14.11	1	.5	.5	47.1
14.12	4	2.1	2.1	49.2
14.13	2	1.0	1.1	50.3
14.14	1	.5	.5	50.8
14.15	3	1.6	1.6	52.4
14.17	3	1.6	1.6	54.0
14.18	2	1.0	1.1	55.0
14.19	4	2.1	2.1	57.1
14.20	1	.5	.5	57.7
14.21	4	2.1	2.1	59.8
14.22	3	1.6	1.6	61.4
14.23	1	.5	.5	61.9
14.24	4	2.1	2.1	64.0
14.25	1	.5	.5	64.6
14.26	3	1.6	1.6	66.1
14.27	1	.5	.5	66.7
14.28	2	1.0	1.1	67.7
14.29	1	.5	.5	68.3
14.30	4	2.1	2.1	70.4
14.32	1	.5	.5	70.9
14.33	3	1.6	1.6	72.5
14.34	2	1.0	1.1	73.5
14.35	2	1.0	1.1	74.6
14.36	3	1.6	1.6	76.2
14.39	2	1.0	1.1	77.2
14.40	7	3.6	3.7	81.0
14.43	1	.5	.5	81.5
14.44	2	1.0	1.1	82.5
14.45	1	.5	.5	83.1
14.46	2	1.0	1.1	84.1
14.48	2	1.0	1.1	85.2
14.49	1	.5	.5	85.7
14.50	6	3.1	3.2	88.9
14.51	1	.5	.5	89.4
14.52	2	1.0	1.1	90.5
14.53	1	.5	.5	91.0
14.54	1	.5	.5	91.5
14.56	1	.5	.5	92.1

VOLTAGE READINGS AT BATTERY AT HIGH IDLE (continued)

Value	Frequency	Percent	Valid Percent	Cum Percent
14.58	3	1.6	1.6	93.7
14.59	2	1.0	1.1	94.7
14.63	1	.5	.5	95.2
14.65	2	1.0	1.1	96.3
14.67	1	.5	.5	96.8
14.70	2	1.0	1.1	97.9
14.72	2	1.0	1.1	98.9
14.80	1	.5	.5	99.5
14.81	1	.5	.5	100.0
.	3	1.6	MISSING	
TOTAL	192	100.0	100.0	

VOLTAGE READINGS AT BATTERY AT HIGH IDLE (continued)



* Values are presented at intervals of .50 volts

Mean	14.082	Std Err	.030	Median	14.130
Mode	14.400	Std Dev	.423	Variance	.179
Range	2.690	Minimum	12.120	Maximum	14.810

APPENDIX I

CORRELATIONS OF REAR LIGHTING SYSTEM VARIABLES

TABLE OF ABBREVIATIONS FOR VARIABLES IN REAR LIGHTING SYSTEM CORRELATIONAL ANALYSIS

VEHICTYP = TYPE OF VEHICLE: 1=CAR, 2=VAN, 3=PICKUP, 4=UTILITY VEHICLE
VEHICYR = YEAR VEHICLE WAS BUILT
ODOMETER = ODOMETER READING AT TIME OF DATA COLLECTION
AMSPLFLO = AMPERAGE READING AT LEFT STOP LAMP AT LOW IDLE
AMSPLFHI = AMPERAGE READING AT LEFT STOP LAMP AT HIGH IDLE
AMSPRTLO = AMPERAGE READING AT RIGHT STOP LAMP AT LOW IDLE
AMSPRTHI = AMPERAGE READING AT RIGHT STOP LAMP AT HIGH IDLE
VOSPLFLO = VOLTAGE READING AT LEFT STOP LAMP AT LOW IDLE
VOSPLFHI = VOLTAGE READING AT LEFT STOP LAMP AT HIGH IDLE
VOSPRTLO = VOLTAGE READING AT RIGHT STOP LAMP AT LOW IDLE
VOSPRTHI = VOLTAGE READING AT RIGHT STOP LAMP AT HIGH IDLE
AMPRLFLO = AMPERAGE READING AT LEFT PRES LAMP AT LOW IDLE
AMPRLFHI = AMPERAGE READING AT LEFT PRES LAMP AT HIGH IDLE
AMPRRTLO = AMPERAGE READING AT RIGHT PRES LAMP AT LOW IDLE
AMPRRTHI = AMPERAGE READING AT RIGHT PRES LAMP AT HIGH IDLE
VOPRLFLO = VOLTAGE READING AT LEFT PRES LAMP AT LOW IDLE
VOPRLFHI = VOLTAGE READING AT LEFT PRES LAMP AT HIGH IDLE
VOPRRTLO = VOLTAGE READING AT RIGHT PRES LAMP AT LOW IDLE
VOPRRTHI = VOLTAGE READING AT RIGHT PRES LAMP AT HIGH IDLE
AMSGLFLO = AMPERAGE READING AT LEFT SIGNAL LAMP AT LOW IDLE
AMSGLFHI = AMPERAGE READING AT LEFT SIGNAL LAMP AT HIGH IDLE
AMSGRTLO = AMPERAGE READING AT RIGHT SIGNAL LAMP AT LOW IDLE
AMSGRTHI = AMPERAGE READING AT RIGHT SIGNAL LAMP AT HIGH IDLE
VOSGLFLO = VOLTAGE READING AT LEFT SIGNAL LAMP AT LOW IDLE
VOSGLFHI = VOLTAGE READING AT LEFT SIGNAL LAMP AT HIGH IDLE
VOSGRTLO = VOLTAGE READING AT RIGHT SIGNAL LAMP AT LOW IDLE
VOSGRTHI = VOLTAGE READING AT RIGHT SIGNAL LAMP AT HIGH IDLE
VOBATTLO = VOLTAGE READING AT BATTERY AT LOW IDLE
VOBATTHI = VOLTAGE READING AT BATTERY AT HIGH IDLE
AIRTEMP = AIR TEMP IN FAHRENHEIT DURING DATA COLLECTION
VEHLENGT = LENGTH OF VEHICLE IN INCHES
NUMBULBS = NUMBER OF BULBS FOR STOP, PRESENCE, AND TURN SIGNAL LAMPS PER SIDE
SGAMBER = TURN SIGNAL LAMPS: 1=ARE AMBER, OR 2=ARE NOT AMBER

CORRELATIONS OF REAR LIGHTING SYSTEM VARIABLES

	VEHICTYP	VEHICYR	ODOMETER	AMSPLFLO	AMSPLFHI	AMSPRTLO	AMSPRTHI	VOSPLFLO	VOSPLFHI	VOSPRTLO	VOSPRTHI	AMPRLFLO
VEHICTYP	1.0000	-.0761	.0860	.0624	.0247	.0508	.0158	.4400**	.4166**	.4101**	.3904**	-.0480
VEHICYR	-.0761	1.0000	-.6858**	.0072	.0433	.0638	.0769	.0411	.1315	-.0084	.0801	-.0689
ODOMETER	.0860	-.6858**	1.0000	.0858	.0731	.0252	.0117	.0049	-.0830	.0572	-.0358	.1565
AMSPLFLO	.0624	.0072	.0858	1.0000	.9760**	.8891**	.8794**	.1216	.0842	.1189	.0991	.1693
AMSPLFHI	.0247	.0433	.0731	.9760**	1.0000	.8930**	.9059**	.0294	.0958	.0256	.1097	.1704
AMSPRTLO	.0508	.0638	.0252	.8891**	.8930**	1.0000	.9806**	.0811	.0739	.0740	.0784	.1138
AMSPRTHI	.0158	.0769	.0117	.8794**	.9059**	.9806**	1.0000	.0047	.0755	.0026	.0901	.1097
VOSPLFLO	.4400**	.0411	.0049	.1216	.0294	.0811	.0047	1.0000	.7180**	.9620**	.6990**	-.0491
VOSPLFHI	.4166**	.1315	-.0830	.0842	.0958	.0739	.0755	.7180**	1.0000	.6951**	.9518**	-.0908
VOSPRTLO	.4101**	-.0084	.0572	.1189	.0256	.0740	.0026	.9620**	.6951**	1.0000	.7290**	.0016
VOSPRTHI	.3904**	.0801	-.0358	.0991	.1097	.0784	.0901	.6990**	.9518**	.7290**	1.0000	-.0400
AMPRLFLO	-.0480	-.0689	.1565	.1693	.1704	.1138	.1097	-.0491	-.0908	.0016	-.0400	1.0000
AMPRLFHI	-.0616	-.0631	.1385	.1631	.1815	.1253	.1296	-.0760	-.0520	-.0279	-.0078	.9789**
AMPRRTLO	-.1272	.1167	.0109	.2124*	.2231*	.2576*	.2743**	-.1057	-.1071	-.0742	-.0690	.6445**
AMPRRTHI	-.1455	.1142	.0077	.1966	.2247*	.2503*	.2814**	-.1531	-.0918	-.1203	-.0569	.6258**
VOPRLFLO	.2703**	.1258	-.0194	.1521	.0801	.1153	.0228	.7637**	.5236**	.7162**	.4920**	-.0099
VOPRLFHI	.2056	.2553*	-.0824	.1533	.1812	.1385	.1142	.5023**	.7086**	.4535**	.6483**	-.0470
VOPRRTLO	.2338*	.1303	-.0421	.1282	.0520	.1068	.0227	.7785**	.5041**	.7500**	.4903**	-.0046
VOPRRTHI	.1910	.2274*	-.0850	.1213	.1534	.1439	.1317	.5027**	.7239**	.4600**	.6816**	-.0502
AMSGLFLO	-.0034	.1400	-.0104	.8021**	.8081**	.8340**	.8302**	-.0114	-.0438	-.0258	-.0186	.1944
AMSGLFHI	-.0291	.1540	-.0184	.7870**	.8148**	.8215**	.8337**	-.0687	-.0414	-.0826	-.0201	.1895
AMSGRTLO	.0194	.1166	-.0006	.7953**	.8066**	.8911**	.8886**	-.0283	-.0311	-.0421	-.0205	.1285
AMSGRTHI	-.0047	.1226	-.0060	.7784**	.8088**	.8750**	.8888**	-.0929	-.0281	-.1091	-.0238	.1150
VOSGLFLO	.3323**	.0863	.0112	.0865	-.0066	.0468	-.0245	.8562**	.5613**	.8404**	.5497**	.0320
VOSGLFHI	.3062**	.1611	-.0256	.0291	.0520	.0313	.0423	.5274**	.7699**	.5130**	.7346**	.0011
VOSGRTLO	.2819**	.0151	.0650	.0948	-.0042	.0486	-.0276	.8464**	.5428**	.8641**	.5449**	.0438
VOSGRTHI	.2706**	.1490	-.0484	.0287	.0385	.0086	.0141	.5725**	.7821**	.5749**	.7641**	.0070
VOBATTLO	.1805	.0370	.0382	.0987	.0201	.0692	-.0023	.5397**	.2577*	.5275**	.2386*	-.0048
VOBATTHI	.1982	.1749	-.0415	.0967	.0949	.0709	.0568	.3127**	.4844**	.2847**	.4417**	-.0734
AIRTEMP	.2084	-.1438	.0937	.0659	.0016	.0533	.0132	.1378	-.1165	.1495	-.0666	.0453
VEHLENGT	.5118**	.0673	.0574	-.0525	-.0723	-.0485	-.0734	.1053	.0586	.0885	.0414	.0713
NUMBULBS	-.3399**	.1431	-.0691	-.0600	-.0593	-.0519	-.0499	-.2812**	-.4610**	-.3363**	-.4872**	-.0525
SGAMBER	.2500*	.1298	-.1467	.1377	.1051	.0911	.0852	.1868	.1094	.1583	.0882	-.1833

2-tailed Significance: * - .01 ** - .001

Note: A significant negative correlation indicates that values of one variable tend to increase as values of the other variable tend to decrease. Conversely, a significant postitive correlation indicates that values of one variable tend to increase as values of the other variable also tend to increase. Correlations of particular interest are highlighted.

CORRELATIONS OF REAR LIGHTING SYSTEM VARIABLES (continued)

	AMPRLFHI	AMPRRTLO	AMPRRTHI	VOPRLFLO	VOPRLFHI	VOPRRTLO	VOPRRTHI	AMSGLFLO	AMSGLFHI	AMSGRTLO	AMSGRTHI	VOSGLFLO
VEHICTYP	-.0616	-.1272	-.1455	.2703**	.2056	.2338*	.1910	-.0034	-.0291	.0194	-.0047	.3323**
VEHICYR	-.0631	.1167	.1142	.1258	.2553*	.1303	.2274*	.1400	.1540	.1166	.1226	.0863
ODOMETER	.1385	.0109	.0077	-.0194	-.0824	-.0421	-.0850	-.0104	-.0184	-.0006	-.0060	.0112
AMSPLFLO	.1631	.2124*	.1966	.1521	.1533	.1282	.1213	.8021**	.7870**	.7953**	.7784**	.0865
AMSPLFHI	.1815	.2231*	.2247*	.0801	.1812	.0520	.1534	.8081**	.8148**	.8066**	.8088**	-.0066
AMSPRTLO	.1253	.2576*	.2503*	.1153	.1385	.1068	.1439	.8340**	.8215**	.8911**	.8750**	.0468
AMSPRTHI	.1296	.2743**	.2814**	.0228	.1142	.0227	.1317	.8302**	.8337**	.8886**	.8888**	-.0245
VOSPLFLO	-.0760	-.1057	-.1531	.7637**	.5023**	.7785**	.5027**	-.0114	-.0687	-.0283	-.0929	.8562**
VOSPLFHI	-.0520	-.1071	-.0918	.5236**	.7086**	.5041**	.7239**	-.0438	-.0414	-.0311	-.0281	.5613**
VOSPRTLO	-.0279	-.0742	-.1203	.7162**	.4535**	.7500**	.4600**	-.0258	-.0826	-.0421	-.1091	.8404**
VOSPRTHI	-.0078	-.0690	-.0569	.4920**	.6483**	.4903**	.6816**	-.0186	-.0201	-.0205	-.0238	.5497**
AMPRLFLO	.9789**	.6445**	.6258**	-.0099	-.0470	-.0046	-.0502	.1944	.1895	.1285	.1150	.0320
AMPRLFHI	1.0000	.6341**	.6314**	-.0534	-.0121	-.0410	-.0154	.1910	.1976	.1364	.1361	.0041
AMPRRTLO	.6341**	1.0000	.9882**	-.0683	-.0741	-.0516	-.0352	.2461*	.2367*	.2480*	.2348*	-.0443
AMPRRTHI	.6314**	.9882**	1.0000	-.1298	-.0655	-.1074	-.0240	.2336*	.2372*	.2455*	.2466*	-.1016
VOPRLFLO	-.0534	-.0683	-.1298	1.0000	.7359**	.9455**	.7042**	.1078	.0578	.0789	.0119	.7793**
VOPRLFHI	-.0121	-.0741	-.0655	.7359**	1.0000	.6721**	.9464**	.1145	.1218	.1233	.1211	.5056**
VOPRRTLO	-.0410	-.0516	-.1074	.9455**	.6721**	1.0000	.6984**	.1086	.0565	.0940	.0219	.8077**
VOPRRTHI	-.0154	-.0352	-.0240	.7042**	.9464**	.6984**	1.0000	.1187	.1258	.1268	.1258	.4956**
AMSGLFLO	.1910	.2461*	.2336*	.1078	.1145	.1086	.1187	1.0000	.9901**	.9140**	.9013**	.0160
AMSGLFHI	.1976	.2367*	.2372*	.0578	.1218	.0565	.1258	.9901**	1.0000	.9072**	.9098**	-.0386
AMSGRTLO	.1364	.2480*	.2455*	.0789	.1233	.0940	.1268	.9140**	.9072**	1.0000	.9891**	-.0017
AMSGRTHI	.1361	.2348*	.2466*	.0119	.1211	.0219	.1258	.9013**	.9098**	.9891**	1.0000	-.0693
VOSGLFLO	.0041	-.0443	-.1016	.7793**	.5056**	.8077**	.4956**	.0160	-.0386	-.0017	-.0693	1.0000
VOSGLFHI	.0410	-.0400	-.0298	.4975**	.6799**	.4801**	.6769**	.0046	.0143	.0150	.0241	.6841**
VOSGRTLO	.0208	-.0553	-.1121	.7309**	.4623**	.7883**	.4623**	.0067	-.0532	-.0184	-.0922	.9229**
VOSGRTHI	.0457	-.0732	-.0669	.5149**	.6726**	.5376**	.6774**	-.0192	-.0162	-.0086	-.0091	.6660**
VOBATTLO	-.0371	-.0821	-.1234	.6359**	.4162**	.6856**	.4152**	.0771	.0433	.0443	-.0160	.6286**
VOBATTHI	-.0452	-.1214	-.1141	.4933**	.6752**	.4680**	.6569**	.0730	.0791	.0581	.0554	.3910**
AIRTEMP	.0249	.0085	-.0179	-.0300	-.1921	-.0221	-.2390*	.0309	-.0139	.0458	.0141	.1121
VEHLENGT	.0396	-.0449	-.0711	.0874	.0786	.0686	.0296	-.0336	-.0541	-.0024	-.0202	.1780
NUMBULBS	-.0473	-.0660	-.0648	-.1354	-.2375*	-.1187	-.2442*	.0715	.0861	.0099	.0175	-.1555
SGAMBER	-.1941	-.2792**	-.2974**	.1696	.1338	.1776	.1076	.1063	.0900	.0866	.0683	.1749

2-tailed Significance: * - .01 ** - .001

Note: A significant negative correlation indicates that values of one variable tend to increase as values of the other variable tend to decrease. Conversely, a significant postitive correlation indicates that values of one variable tend to increase as values of the other variable also tend to increase. Correlations of particular interest are highlighted.

CORRELATIONS OF REAR LIGHTING SYSTEM VARIABLES (continued)

	VOSGLFHI	VOSGRTLO	VOSGRTHI	VOBATTLO	VOBATTHI	AIRTEMP	VEHLENGT	NUMBULBS	SGAMBER
VEHICTYP	.3062**	.2819**	.2706**	.1805	.1982	.2084	.5118**	-.3399**	.2500*
VEHICYR	.1611	.0151	.1490	.0370	.1749	-.1438	.0673	.1431	.1298
ODOMETER	-.0256	.0650	-.0484	.0382	-.0415	.0937	.0574	-.0691	-.1467
AMSPLFLO	.0291	.0948	.0287	.0987	.0967	.0659	-.0525	-.0600	.1377
AMSPLFHI	.0520	-.0042	.0385	.0201	.0949	.0016	-.0723	-.0593	.1051
AMSPRTLO	.0313	.0486	.0086	.0692	.0709	.0533	-.0485	-.0519	.0911
AMSPRTHI	.0423	-.0276	.0141	-.0023	.0568	.0132	-.0734	-.0499	.0852
VOSPLFLO	.5274**	.8464**	.5725**	.5397**	.3127**	.1378	.1053	-.2812**	.1868
VOSPLFHI	.7699**	.5428**	.7821**	.2577*	.4844**	-.1165	.0586	-.4610**	.1094
VOSPRTLO	.5130**	.8641**	.5749**	.5275**	.2847**	.1495	.0885	-.3363**	.1583
VOSPRTHI	.7346**	.5449**	.7641**	.2386*	.4417**	-.0666	.0414	-.4872**	.0882
AMPRLFLO	.0011	.0438	.0070	-.0048	-.0734	.0453	.0713	-.0525	-.1833
AMPRLFHI	.0410	.0208	.0457	-.0371	-.0452	.0249	.0396	-.0473	-.1941
AMPRRTLO	-.0400	-.0553	-.0732	-.0821	-.1214	.0085	-.0449	-.0660	-.2792**
AMPRRTHI	-.0298	-.1121	-.0669	-.1234	-.1141	-.0179	-.0711	-.0648	-.2974**
VOPRLFLO	.4975**	.7309**	.5149**	.6359**	.4933**	-.0300	.0874	-.1354	.1696
VOPRLFHI	.6799**	.4623**	.6726**	.4162**	.6752**	-.1921	.0786	-.2375*	.1338
VOPRRTLO	.4801**	.7883**	.5376**	.6856**	.4680**	-.0221	.0686	-.1187	.1776
VOPRRTHI	.6769**	.4623**	.6774**	.4152**	.6569**	-.2390*	.0296	-.2442*	.1076
AMSGLFLO	.0046	.0067	-.0192	.0771	.0730	.0309	-.0336	.0715	.1063
AMSGLFHI	.0143	-.0532	-.0162	.0433	.0791	-.0139	-.0541	.0861	.0900
AMSGRTLO	.0150	-.0184	-.0086	.0443	.0581	.0458	-.0024	.0099	.0866
AMSGRTHI	.0241	-.0922	-.0091	-.0160	.0554	.0141	-.0202	.0175	.0683
VOSGLFLO	.6841**	.9229**	.6660**	.6286**	.3910**	.1121	.1780	-.1555	.1749
VOSGLFHI	1.0000	.6009**	.8936**	.3039**	.5296**	-.0999	.1692	-.3060**	.0411
VOSGRTLO	.6009**	1.0000	.6932**	.6456**	.3682**	.1120	.1697	-.1691	.1578
VOSGRTHI	.8936**	.6932**	1.0000	.3381**	.5370**	-.1192	.1512	-.3055**	.0716
VOBATTLO	.3039**	.6456**	.3381**	1.0000	.6622**	.0238	.2110*	-.0527	.2496*
VOBATTHI	.5296**	.3682**	.5370**	.6622**	1.0000	-.1451	.2419*	-.1579	.2044
AIRTEMP	-.0999	.1120	-.1192	.0238	-.1451	1.0000	.2151*	-.0146	.0170
VEHLENGT	.1692	.1697	.1512	.2110*	.2419*	.2151*	1.0000	-.0915	.2158*
NUMBULBS	-.3060**	-.1691	-.3055**	-.0527	-.1579	-.0146	-.0915	1.0000	.1168
SGAMBER	.0411	.1578	.0716	.2496*	.2044	.0170	.2158*	.1168	1.0000

2-tailed Significance: * - .01 ** - .001

Note: A significant negative correlation indicates that values of one variable tend to increase as values of the other variable tend to decrease. Conversely, a significant postitive correlation indicates that values of one variable tend to increase as values of the other variable also tend to increase. Correlations of particular interest are highlighted.

APPENDIX J

RAW DATA FROM PHOTOMETRIC LABORATORY

RAW DATA FROM PHOTOMETRIC LABORATORY

Photometric Results Using Standard Voltage (12.9 volts)

Photometric (Test distance: 60 feet) - Calibrated Bulb Setting
(Bulb Trade No. 2057) - Two

Test Points	Candlepower, Stop Lamp, 32-cp Filament, Measured	Specified Minimum, Red
10°U-5°L	94	19
5°R	90	19
20°L	66	12
10°L	114	36
5°U-V	153	83
10°R	109	36
20°R	69	12
10°L	129	47
5°L	156	95
Hor.-V	170	95
5°R	145	95
10°R	115	47
20°L	75	12
10°L	121	36
5°D-V	149	83
10°R	116	36
20°R	78	12
10°D-5°L	94	19
5°R	95	19
		Specified Maximum
Maximum:	174	360
Location:	0.42°D-1.65°L	

Bulbs operated at rated mean spherical candlepower.

Volts:	12.9
Amperes:	4.20

RAW DATA FROM PHOTOMETRIC LABORATORY (continued)

Photometric Results Using Intermediate Voltage (11.64 volts)

Photometric (Test distance: 60 feet) - Mid Voltage of 11.635
(Bulb Trade No. 2057) - Two

Test Points	Candlepower Stop Lamp 32-cp Filament Measured	Specified Minimum Red
10°U-5°L	64	19
5°R	61	19
20°L	46	12
10°L	79	36
5°U-V	107	83
10°R	76	36
20°R	48	12
10°L	90	47
5°L	108	95
Hor.-V	119	95
5°R	101	95
10°R	81	47
20°L	53	12
10°L	85	36
5°D-V	105	83
10°R	81	36
20°R	54	12
10°D-5°L	66	19
5°R	67	19

		Specified Maximum
Maximum:	122	360
Location:	0.40°D-1.30°L	

Bulbs operated at voltage requested.
Volts: 11.64
Amperes: 3.952

RAW DATA FROM PHOTOMETRIC LABORATORY (continued)

Photometric Results Using Selected Field Voltage (10.42 volts)

Photometric (Test distance: 60 feet) - Voltage of 10.42
(Bulb Trade No. 2057) - Two

Test Points	Candlepower Stop Lamp 32-cp Filament Measured	Specified Minimum Red
10°U-5°L	45	19
5°R	43	19
20°L	32	12
10°L	55	36
5°U-V	74*	83
10°R	53	36
20°R	33	12
10°L	62	47
5°L	75*	95
Hor.-V	83*	95
5°R	70*	95
10°R	56	47
20°L	37	12
10°L	59	36
5°D-V	73*	83
10°R	56	36
20°R	38	12
10°D-5°L	46	19
5°R	46	19
		Specified Maximum
Maximum:	85	360
Location:	0.63°D-1.93°L	

Bulbs operated at voltage requested.
Volts: 10.42
Amperes: 3.725

* = Fails to Comply